# INVENTORIES OF APPARATUS AND MATERIALS FOR TEACHING SCIENCE

VOLUME III
TECHNICAL COLLEGES
PART 3
AGRICULTURAL SCIENCES

UNESCO

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SENIOR BA COLLEGE

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E/12

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TECHNICAL COLLEGES
PART 3
AGRICULTURAL SCIENCES

UNESCO PARIS

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*United Nations Educational,*
*Scientific and Cultural Organization*
*Printed by Imprimerie Centrale de Lausanne*
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*Unesco Publication 839*

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# PREFACE

Educational and cultural rehabilitation has been, and still is, one of the chief problems confronting the post-war world. Educational and cultural centres, such as schools, colleges, laboratories, libraries, museums, were either destroyed or looted on a large scale during the last war. The task of restoring them to their pre-war conditions has been vast and it is far from being completed. In addition there has been an awakening to the urgent need for expanding all forms of education especially in underdeveloped regions.

Everywhere there is an increasing awareness that it is important to provide greater facilities for teaching science and technology. This trend is obviously due to the immense changes that science and technology have produced in man's ability to understand nature's mysteries and to control and utilize its forces for his purposes. It is not surprising therefore, that wherever peoples are confronted with low standards of life and try to improve them, they turn to science and technology.

To implement the plans that have been prepared for the adequate teaching of science in schools and colleges in the war-damaged and in the underdeveloped regions is admittedly a long-range enterprise. Any guidance towards improved techniques in this field of education would surely be of great help to the authorities concerned. For this reason, Unesco is presenting, together with the corresponding curricula, a series of inventories of apparatus and materials for teaching science at all levels. It is hoped that these publications will be useful to educators as reference manuals for selecting essential equipment from the lists commonly used in some of the leading countries; for clarity the lists are related to corresponding curricula. To develop the information given in the Inventories, Unesco is now planning a series of ten handbooks for science teachers in underdeveloped countries. By diffusing information of this comparative kind on the training of students, the Inventories may well contribute also to bringing about equivalence of degrees and diplomas in science and engineering, irrespective of the universities and institutions where they are awarded.

Such an approach to the problem of scientific reconstruction was initiated by the Conference of Allied Ministers of Education which was first held in London in 1943. The Science Commission set up by that conference issued in 1945 a limited set of inventories of basic scientific equipment as an *aide-mémoire* to the governments of occupied Europe, to assist them in rehabilitating scientific education.

Unesco Inventories are being published in three volumes and in several languages: Volume I will group information bearing on Primary, Secondary and Vocational Schools; Volume II, on Universities; and Volume III, on Technical Colleges. While prices of items of equipment are mentioned in U.S. dollars whenever possible in the Inventories, these should be taken more as indicative than exact, owing to the prevailing fluctuations both in the cost and in the quality of available apparatus. However, when a specific request arises for more detailed and up-to-date information for installing a school or a college laboratory, Unesco will attempt to furnish the answer.

The Inventories have been compiled from reports submitted by experts from six countries generally considered to lead in the field of science education. Unesco expresses its thanks to Marcel Peschard, France; S. W. Tromp, Netherlands; Gunnar Hambraeus, Sweden; Pierre Speziali, Switzerland; J. P. Stephenson and R. Thurlow, United Kingdom, for submitting reports at short notice; and its appreciation to Norman R. D. Jones, President of the National Science Teachers Association of the United States, for his generous permission to make use of the valuable information published by the Association on " Science course content and teaching apparatus used in schools and colleges of the United States ".

# INTRODUCTION

For reasons of convenience it has seemed preferable to publish Volume III of the *Inventories of Apparatus and Materials for Teaching Science* in separate parts; this volume, it will be remembered, deals with technical colleges. This, the third part, is devoted to agricultural sciences.

The reader will find first a brief account of the organization of a certain number of schools for the teaching of agricultural sciences chosen from different countries, then lists of apparatus, instruments, and other equipment necessary for such schools. To illustrate the lists we give as an example for each of them a syllabus of courses for which such equipment is necessary.

## HIGHER TEACHING OF AGRICULTURE IN FRANCE.

Like classical university and secondary education, agricultural teaching covers three stages but, in contrast to the former, it comes under the Ministry of Agriculture. The three stages are: primary education; secondary education; higher education. The latter is given at the *Institut national agronomique* (National Agronomical Institute) which is devoted to the study of physical, biological and economical sciences in relation to agricultural production and the various forms of rural activity, and in the *Ecoles nationales d'agriculture* (National Schools of Agriculture) of which there are four: Grignon, Montpellier, Rennes and Algiers, and where the teaching is more experimental and practical.

We shall describe the organization of teaching at the National Agronomic Institute (INA).

### *Aim.*

The aim of the National Agronomical Institute is to train agronomical engineers for:

Private careers:

- Agricultural experts capable of working rationally productive estates in France and her overseas territories either as owner, tenant or salaried manager.
- Executive and technical staff in certain chemical, mechanical and processing industries (production or designing engineers, workers in technical, commercial, research and publicity services, administrators, directors, etc.).
- Experts for agricultural marketing and banking firms.
- Directors of professional agricultural organizations (trade unions, farmers' co-operatives, mutual credit and insurance companies, etc.).

Civil service in France:

- Officers of the Forestry Corps (after special training at the *Ecole nationale des eaux et forêts*).
- Engineers of the Agricultural Improvement Corps (after special training at the *Ecole du génie rural* where questions relating to electrification, irrigation, drainage, farm buildings, and other technical problems are studied).
- Officers of the State Stud Farms Corps (after special training at the *Ecole nationale des haras*).
- Officers of the Advisory (Extension) Service and teachers in secondary winter agricultural schools.
- Members of the Plant Protection Service (after special training at the *Ecole nationale supérieure des sciences agronomiques appliquées)*.
- Members of the Agricultural Research Administration.
- Members of other administrative offices concerned with agricultural matters (such as the National Railways, the National Farm Credit Bank, the Weather Bureau, the State Tobacco Monopoly, etc.).

Overseas Civil Service:

- Officers of the Forestry Corps, Engineers of the Agricultural Improvement Corps (these two form a single body of specialists throughout the whole of the French Union).

Officers of the Advisory (Extension) Service and members of the Research Services (after special training at the *Ecole supérieure d'application d'agriculture tropicale*).

*Admission.*

One hundred and twenty students are admitted to the School annually by competition. They are selected from about six hundred candidates who have been prepared in the secondary schools or in some private establishments, both of which have specialized classes for this purpose.

The preparation generally takes two years after the Baccalaureate. Although no certificate is demanded as condition of entry to the competition, in fact all the candidates have passed their Baccalaureate in mathematics. There is no upper age limit but candidates must be at least 17 years of age. Girls are allowed to compete on the same conditions as boys.

Admission requires knowledge of the following subjects: elements of scientific and moral philosophy, mathematics, physics, chemistry, cell biology, animal biology, zoology, plant biology, geology, physical and economic geography, modern languages.

*Teaching.*

The above remarks about new entrants will indicate the complexity of the scientific and technical knowledge which it is desirable that future agronomists should be taught. This is why, after two years of general agronomical teaching, students have to specialize.

Part of the students leave the Institute after their second year and complete their studies in other institutions while the rest stay at the NAI for a third year of specialization. The other institutions are:

*Ecole nationale des eaux et forêts* (National School of Water and Forests); two years' course;

*Ecole nationale du génie rural* (National School of Agricultural Engineering); two years' course;

*Ecole nationale des haras* (National Haras School); two years' course;

*Ecole nationale supérieure des sciences agronomiques appliquées* (National Institute of Applied Agronomical Sciences); two years' course;

*Ecole supérieure d'application d'agriculture tropicale* (Higher Training School for Tropical Agriculture); one year course.

Entrance to these training schools is by class order at the end of the second year of studies.

On leaving the training school, students of the National Agronomical Institute receive the title appropriate to their school in addition to their agricultural engineering diploma.

Students remaining at the NAI for their third year are divided in three divisions:

(1) Research division: the aim of which is to train young men who are intending to take up higher teaching posts, agricultural research work in laboratories, experimental stations, or centres of study and research.

(2) Agricultural industries division: which aims at training engineers and managers for firms in industries dealing with raw materials of agricultural origin or working to satisfy the needs of agriculture.

(3) Agricultural division: the object of which is to train agricultural experts, who will have to deal with technical questions of direct interest to agricultural production (popularization of rational techniques, commerce of agricultural products, agricultural professional organizations, etc.).

At the end of their third year, students receive the title of agronomical engineer and a diploma in their special subject.

Tables 1 and 2 give a general picture of the teaching given at the NAI.

In addition to practical work, and visits to farms or factories, several periods of probationary work outside have to be undertaken during the course. A first probationary period, before entry to the school, provides an introduction to rural life; a second, between the first and second years of the course, is devoted mainly to the technical running of an agricultural establishment; finally, during the third year, one or two periods, according to the particular section concerned, aim at completing the student's technical knowledge while at the same time introducing them practically to economic and social questions and to matters of scientific organization.

During the third year, actual teaching is reduced to enable students to study individually; work in small groups brings students and teachers into close contact.

## HIGHER AGRICULTURAL TEACHING IN THE NETHERLANDS.

Agricultural teaching in the Netherlands falls into four categories: elementary, secondary, higher education and specialized schools. Higher education is given at the Agricultural University at Wageningen (Landhouwhoogschool te Wageningen). It is organized as follows:

The courses last five years and are completed by the diploma of Agricultural Engineer (Landhouwkundig Engenieur). To be admitted, candidates must hold the diploma of an intermediate agricultural high school. There is no entrance examination.

Studies can take any of three main directions: agriculture, horticulture, forestry. Each of these main categories is subdivided into sections which the student chooses after passing the first examination as explained below. These are:

(1) Agriculture.
  (*a*) Agriculture in temperate regions:
    A1. Arable and grass land farming section.
    A2. Animal husbandry section.
    A3. Dairying section.
    A4. Economics section.
    A5. Technical development section.
  (*b*) Agriculture in tropical regions:
    B1. Tropical cultures section.
    B2. Animal husbandry section.
    B3. Economics section.
(2) Horticulture.
  (*a*) Horticulture section.
  (*b*) Garden and landscape architecture section.
(3) Forestry.
  (*a*) Forestry in temperate regions.
  (*b*) Tropical forestry.

During the course students have to pass three examinations:
the "Propaedeuse" examination, after sixteen months,
the "Candidaats" examination, two years after the first examination,
the "Engenieurs" examination, a year later still.

Before starting on the final year, students have to complete a six-months' probationary period on an agricultural productive establishment where they are introduced to country life and acquire the necessary practical experience.

The syllabus for the first examination is common to all sections, students do not specialize until after having taken it.

Table 3 shows the programme of lectures and practical work for the agriculture in temperate regions section.

The syllabus for the "Candidaats" examination includes compulsory subjects and optional ones which the student is free to choose. The diploma granted at the end of the course mentions the additional optional subjects. This system was chosen partly to stimulate individual work and partly because the courses in the various sections are too numerous for any one student to be able to follow them all.

In addition to the practical probationary period already mentioned, students have to spend two other periods of six weeks on a farm, at a horticultural establishment, or with a forester, according to their special subject. At the end of these periods students have to submit reports on the work they have been doing.

## HIGHER AGRICULTURAL TEACHING IN THE UNITED STATES OF AMERICA.

Agricultural teaching is in three grades: elementary, secondary and higher. The latter is given in Colleges or Universities. A normal course generally lasts four years, at the end of which the student receives the title of Bachelor of Sciences in agriculture.

During the first two years studies are usually not specialized, and they include agriculture, domestic economy and industrial arts, and particularly the basic sciences such as chemistry, physics, botany, zoology, bacteriology, entomology; they also include English, mathematics, history, economics and agricultural subjects.

During the next two years studies are specialized: candidates can choose between special syllabuses the chief of which are: agricultural economy and rural sociology; agricultural teaching; agricultural engineering; agronomy; stock-raising; dairy stock-raising; horticulture. Agricultural colleges usually also offer a four-years' course in agricultural commerce, intended for the training of directors of co-operative commercial organizations; in the course of the third and fourth years teaching is concentrated particularly on commerce, business psychology, geography, statistics, commercial law, transport, agricultural economy, etc.

Students who cannot stay four years at college can follow a two-years' course; the conditions of admission are the same as for the four-years' courses. These shorter courses result in a certificate.

Students who so desire can continue their studies in their special subject after taking the bachelor degree. They can take post-graduate courses which lead to the higher degrees of Master and Doctor of Sciences.

As an example we shall give below the organization of agricultural teaching at the Michigan State College of Agriculture and Applied Science. This school offers eight general series of courses which are as follows:

(1) The General Agricultural Series which includes majors in Agricultural Economics, Agricultural Extension, Animal Husbandry, Farm Crops, Farm Management, Poultry Husbandry, Rural Sociology and Anthropology, Soil Science, and Pre-theological training.
(2) The Agricultural Engineering Series with majors in Farm Engineering and Agricultural Engineering.
(3) The Dairy Series with majors in Dairy Production and Dairy Manufactures.
(4) The Horticultural Series with majors in Pomology, Vegetable Production, Floriculture and Ornamental Horticulture.
(5) The Landscape series with majors in Landscape Architecture and Urban Planning.
(6) Agricultural Education.
(7) Food Technology.
(8) The Forestry Series with majors in Forest Management for Wildlife Production, Wood Production, Recreational and Municipal Forestry, Forest Utilization and Technology, and Housing and Lumber Merchandizing. In addition the Conservation Institute offers a series of courses planned to familiarize the student with the wise use and conservation of our natural resources.

TABLE 1. ARRANGEMENT OF COURSES AND PRACTICAL WORK GIVEN AT THE "INSTITUT NATIONAL AGRONOMIQUE" (FRANCE). First and second years. General training.

| | First and Second Years L.[1] | P.W.[1] |
|---|---|---|
| (1) *Mathematical, physical and chemical sciences.* | | |
| Mathematics | 22 | — |
| General physics and physical chemistry | 25 | — |
| Meteorology | 10 | — |
| Organic chemistry | 25 | — |
| Biological chemistry and plant physiology | 40 | — |
| Analytical chemistry | 28 | 36 |
| Geology | 35 | 15 |
| Soil Science | 20 | 5 |
| (2) *Biological sciences.* | | |
| Genetics | 30 | 4 |
| Plant biology | 12 | — |

---

[1] L. = lectures. P.W. = practical work.

| | First and Second Years | |
|---|---|---|
| | L. | P.W. |
| Plant botany and pathology | 45 | 30 |
| Zoology | 40 | 20 |
| Animal anatomy and physiology | 25 | 4 |
| Microbiology | 25 | — |
| (3) *Technics.* | | |
| Rural electrotechnics | 15 | 5 |
| Applied mechanics | 26 | 4 |
| Agricultural water supplies | 32 | 12 |
| Rural buildings | 10 | — |
| Agricultural industries | 42 | 10 |
| Agricultural machinery | 40 | 12 |
| Drawing and topography | 30 | — |
| (4) *Plant and animal production.* | | |
| General agriculture | 20 | 10 |
| Special agriculture | 25 | — |
| Viticulture | 15 | 4 |
| Fruticulture | 12 | 5 |
| Comparative agriculture | 20 | —[1] |
| Forestry | 24 | 4 |
| Tropical agriculture | 12 | — |
| Zootechnics | 50 | 15 |
| (5) *Economic sciences.* | | |
| Political economy | 20 | — |
| Rural economy | 25 | — |
| Comparative rural economy and rural sociology | 10 | — |
| Legislation | 20 | — |
| (6) *Foreign languages.* | | |
| English or German | 24 | — |

---

[1] Visits to productive establishments make up this practical work.

TABLE 2. ARRANGEMENT OF COURSES AND PRACTICAL WORK AT THE "INSTITUT NATIONAL AGRONOMIQUE" (FRANCE). Third year. Special training.

| | Scientific section[1] | | | | | | | | Agricultural Industries section | | Agricultural section | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A Physico-Chemistry | | B Biology | | C Agro-geology | | D Zoo-technics | | | | | |
| | L. | P.W. | L. | P.W. | L. | P.W | L. | P.W. | L. | P.W. | L. | P.W. |
| (1) *Mathematical, physical and chemical sciences* | | | | | | | | | | | | |
| Mathematics | — | — | — | — | — | — | — | — | 25 | — | — | — |
| Statistical methods | 15 | 4 | 15 | 4 | 15 | 4 | 15 | 4 | — | — | 15 | 4 |
| General physics | 15 | 12 | 15 | 12 | 15 | 12 | 15 | 12 | 15 | 12 | — | — |
| Thermodynamics | — | — | — | — | — | — | — | — | 8 | 2 | — | — |
| Meteorology | 10 | — | 10 | — | 10 | — | — | — | — | — | — | — |
| Organic chemistry | 10 | 30 | — | — | — | — | — | — | — | — | — | — |
| Biochemistry | 6 | 30 | — | — | — | — | — | — | — | — | — | — |
| General analytic chemistry | — | 20 | — | 20 | — | 20 | — | 20 | — | 20 | — | — |
| Inorganic analytic chemistry | 14 | 20 | — | — | 14 | 20 | — | — | — | — | — | — |
| Geology | — | — | — | — | 25 | 15 | — | — | — | — | — | — |
| Soil science | — | — | — | — | 10 | 15 | — | — | — | — | — | — |
| (2) *Biological sciences* | | | | | | | | | | | | |
| Genetics | 12 | 5 | 24 | 30 | — | — | 12 | 5 | — | — | 12 | 5 |
| Botany and plant pathology | — | — | — | 32 | — | — | — | — | — | — | — | 8 |
| Zoology | — | — | — | 15 | — | — | — | 15 | — | — | — | 15 |
| Animal anatomy and physiology | — | 10 | — | — | — | — | — | 30 | — | — | 10 | — |
| Histology | — | — | — | — | — | — | 10 | 15 | — | — | — | — |
| Microbiology | 10 | 20 | 10 | 20 | 10 | 20 | 10 | 20 | 6 | 15 | — | — |
| (3) *Technics* | | | | | | | | | | | | |
| Electrotechnics | — | — | — | — | — | — | — | — | 15 | 10 | — | — |
| Strength of materials | — | — | — | — | — | — | — | — | 32 | 6 | — | — |
| General architecture | — | — | — | — | — | — | — | — | 21 | 8 | — | — |
| Metallurgy | — | — | — | — | — | — | — | — | 25 | 5 | — | — |
| Wood technology | — | — | — | — | — | — | — | — | 6 | 4 | — | — |
| Co-operative installations | — | — | — | — | — | — | — | — | 15 | — | — | — |
| Agricultural industries | — | — | — | — | — | — | — | — | 60 | 20 | — | — |
| Agricultural machinery | — | — | — | — | — | — | — | — | — | — | 15 | 5 |
| Industrial drawing | — | — | — | — | — | — | — | — | — | 12 | — | — |
| (4) *Plant and animal production* | | | | | | | | | | | | |
| Special agriculture | — | — | — | — | — | — | — | — | — | — | 15 | — |
| Viticulture | — | — | — | — | — | — | — | — | — | — | 15 | — |
| Fruit cultivation | — | — | — | — | — | — | — | — | — | — | 10 | 5 |
| Comparative agriculture | — | — | — | — | — | — | — | — | — | — | 20 | 10[1] |
| Zootechnics | — | — | — | — | — | — | 20 | 30 | — | — | 30 | 10[1] |
| (5) *Economic sciences* | | | | | | | | | | | | |
| Rural economy | — | — | — | — | — | — | — | — | — | — | 25 | 25[2] |
| Comparative rural economy and rural sociology | — | — | — | — | — | — | — | — | — | — | 20 | |
| French political organization | — | — | — | — | — | — | — | — | — | — | 12 | — |
| Social organization | — | — | — | — | — | — | — | — | 8 | — | 8 | — |
| Commercial legislation | — | — | — | — | — | — | — | — | 12 | — | 12 | — |
| Fiscal legislation | — | — | — | — | — | — | — | — | 5 | — | 5 | — |
| Commerce of agricultural products | — | — | — | — | — | — | — | — | — | — | 6 | — |
| Credit insurance cooperation | — | — | — | — | — | — | — | — | — | — | 13 | — |
| Scientific management of agricultural work | — | — | — | — | — | — | — | — | — | — | 12 | — |
| Accounting and estate management | — | — | — | — | — | — | — | — | 18 | — | 18 | — |
| Standardization of agricultural products | — | — | — | — | — | — | — | — | — | — | 12 | — |
| (6) *Foreign languages* | | | | | | | | | | | | |
| English or German | 12 | — | 12 | — | 12 | — | 12 | — | 12 | — | 12 | — |

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[1] The figures indicate courses and practical work in common to all the students in a section or group of a section; during the remainder of their time students work in a laboratory appropriate to their specialization. They also prepare for a licence certificate (Group A: Biochemistry certificate; Group B: General Biology or Genetics certificate; Group C: Mineralogy certificate; Group D: General Physiology certificate).

[2] Joint excursions.

TABLE 3. SYLLABUS AND TIMETABLES OF THE AGRICULTURAL UNIVERSITY AT WAGENINGEN (NETHERLANDS).

Propaedeuse *examination.*

| | First Part | | Second Part | |
|---|---|---|---|---|
| | L.[1] | P.W.[1] | L. | P.W. |
| Mathematics | 3 | — | 1 | — |
| Hydraulics | — | — | 2 | — |
| Mechanical engineering | 1/2 [1] | 2/0 | — | — |
| Physics, meteorology and climatology | 2 | 2 | 2 | — |
| Organic chemistry | 1 | — | 3 | — |
| Physical and colloid chemistry | 2 | 4 | — | — |
| Geology and mineralogy | 2 | 2 | 1 | 2 |
| Botany | 2 | 2 | 2 | 2 |
| Political economy | 2 | — | 2 | — |

Candidaats *examination (Agriculture in temperate regions).*

| | L. | | | | | P.W. |
|---|---|---|---|---|---|---|
| | A1 | A2 | A3 | A4 | A5 | |
| First part. | | | | | | |
| Agricultural field crops | 2 | 2 | 2 | 2 | 2 | — |
| Genetics | 2 | 2 | 2 | 2 | — | — |
| Botany | 2 | 2 | 2 | 2 | — | except A5 |
| Mathematical working up of observations | | | | | | — |
| Mathematical foundations of geodesy | — | — | — | — | 1 | — |
| Microbiology | 1 | 1 | 1 | — | 1 | A5 |
| Agricultural chemistry | 2 | 2 | 2 | 2 | 2 | for all |
| Cattle breeding | 2 | 2 | 2 | 2 | — | — |
| Anatomy of domestic animals | — | 1 | 1 | — | — | — |
| Physiology of domestic animals | — | 1 | 1 | — | — | A2, A3 |
| Dairy industry | 1 | 1 | 1 | 1 | — | — |
| Agricultural economy | 2 | 2 | 2 | 2 | 2 | — |
| Organic chemistry | — | — | — | — | — | except A5 |
| Agrarian law | — | — | — | 1 | 1 | — |
| Surveying | — | — | — | — | — | A5 |
| Agricultural machinery | 2 | 2 | — | 2 | 2 | — |
| Civil engineering | — | — | — | — | 1 | A5 |
| Phytopathology (Op.) [1] | 1 | 1 | 1 | 1 | 1 | for all |
| Soil science | 1 | 1 | 1 | 1 | 1 | — |
| Calculation of probabilities (Op.) | 2 | 2 | 2 | 2 | 2 | — |
| Utilization of electricity in agriculture (Op.) | 1 | 1 | 1 | 1 | 1 | — |
| Colloid chemistry (Op.) | 1 | 1 | 1 | 1 | 1 | for all |
| First aid (Op.) | 1 | 1 | 1 | 1 | 1 | — |
| Second part. | | | | | | |
| Agricultural field crops | 2 | — | — | 2 | 2 | — |
| Drainage of soil and polders | 2 | 2 | — | 2 | 2 | — |
| Microbiology | — | — | — | — | — | except A5 |
| Agricultural chemistry | 2 | 2 | — | 2 | 2 | except A2 |
| Cattle breeding | — | 2 | 2 | — | — | A2, A3 |
| Hygiene and pathology of domestic animals | 1 | 1 | 1 | — | — | — |
| Physiology of domestic animals | — | 1 | 1 | — | — | A2, A3 |
| Dairy industry | — | 1 | 1 | — | — | A2, A3 |
| Agricultural economy | 1 | 1 | 1 | 2 | 1 | — |

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[1] L. = Lectures, P.W. = Practical work; ½ indicates 1 hour before Christmas, 2 hours subsequently; (Op.) = optional subject; for the meaning of A1, A2, A3, A4, A5, refer to text.

COLLEGE
ANPUR

| | | | L. | | | P.W. |
|---|---|---|---|---|---|---|
| | A1 | A2 | A3 | A4 | A5 | |
| Soil improvement | 2 | 2 | — | 2 | 2 | — |
| Agrarian law | — | — | — | 1 | 1 | — |
| Social statistics | — | — | — | 1 | — | — |
| Economic geography | — | — | — | 1 | — | — |
| Surveying | — | — | — | — | 3 | A5 for all |
| Phytopathology (Op.) | 1 | 1 | 1 | 1 | 1 | |
| Architecture (Op.) | 2 | 2 | 2 | 2 | 2 | — |
| Agricultural technology (Op.) | 1 | 1 | 1 | 1 | 1 | — |
| Soil science (Op.) | 1 | 1 | 1 | 1 | 1 | — |
| Cattle feeding | 1 | 1 | 1 | 1 | 1 | — |
| Engenieurs *examination.* | | | | | | |
| Agricultural field crop | 2 | — | — | — | — | |
| Agricultural chemistry | 3 | — | — | — | 3 | |
| Cattle breeding | — | 3 | — | — | — | |
| Cattle feeding | — | 2 | — | — | — | |
| Dairy industry | — | — | 2 | — | — | |
| Microbiology | — | — | 2 | — | — | |
| Agricultural economy | — | — | — | 2 | — | |
| Agrarian law | — | — | — | 1 | — | |
| Drainage of soil and polders | — | — | — | — | 2 | |
| Principles of mathematical geodesy (Op.) | — | — | — | — | 1 | |
| Surveying (Op.) | — | — | — | — | 2 | |
| Civil engineering (Op.) | — | — | — | — | 1 | |
| Agricultural architecture (Op.) | — | — | — | — | 1 | |
| Soil science (Op.) | — | — | — | — | 2 | |
| Sylviculture and forest preservation (Op.) | — | — | — | — | 2 | |
| Crop improvement (Op.) | 2 | 2 | 2 | 2 | 2 | |
| Physiology of domestic animals (Op.) | 2 | 2 | 2 | 2 | 2 | |
| Economic geography (Op.) | 2 | 2 | 2 | 2 | 2 | |
| Organic chemistry (Op.) | 1 | 1 | 1 | 1 | 1 | |
| Plant physiology (Op.) | 1 | 1 | 1 | 1 | 1 | |
| Genetics (Op.) | 1 | 1 | 1 | 1 | 1 | |
| Phytopathology (Op.) | 1 | 1 | 1 | 1 | 1 | |
| Soil improvement (Op.) | 1 | 1 | 1 | 1 | 1 | |
| Agricultural machinery (Op.) | 1 | 1 | 1 | 1 | 1 | |

TABLE 4. SYLLABUS AND WEEKLY TIMETABLES OF COURSES AT THE MICHIGAN SATE COLLEGE OF AGRICULTURE AND APPLIED SCIENCE (UNITED STATES OF AMERICA). Farm crops section [2].

FIRST YEAR.

| *First term.* | | *Second term.* | | *Third term.* | |
|---|---|---|---|---|---|
| English | 3-2 | English | 3-2 | English | 3-2 |
| Biology | 2-2 | Biology | 3-2 | Biology | 2-2 |
| Effective living | 1-3 | Effective living | 1-3 | Effective living | 1-3 |
| Development of agriculture | 2-0 | Farm poultry | 3-0 | Types of livestock | 2-4 |
| Field crop industry | 2-0 | Soil science | 3-2 | Introduction to dairying | 2-2 |
| Physical education | 0-3 | Physical education | 0-3 | Physical education | 0-3 |

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[1] Practical work takes the form of a six-months' probationary period on a farm.

[2] Each subject is followed by two figures, the first showing the number of hours of practical work per week.

5400
1895
E/125

SECOND YEAR.

| *First term.* | | *Second term.* | | *Third term.* | |
|---|---|---|---|---|---|
| Social science | 3-0 | Social science | 3-0 | Social science | 3-0 |
| History of civilization or literature and fine arts | 3-0 | History of civilization or literature and fine arts | 3-0 | History of civilization or literature and fine arts | 3-0 |
| General chemistry | 2-4 | General chemistry | 2-4 | General chemistry | 3-2 |
| General horticulture | 2-2 | Rural electrification | 2-2 | Agricultural economics or rural sociology | 3-0 |
| Algebra | 3-0 | General botany | 2-4 | Physical education | 0-3 |
| Physical education | 0-3 | Physical education | 0-3 | | |

THIRD AND FOURTH YEARS.

| *First term.* | | *Second term.* | | *Third term.* | |
|---|---|---|---|---|---|
| Elementary mycology | 2-6 | General bacteriology | 2-0 | Elementary plant physiology | 2-6 |
| Biological chemistry | 2-4 | Bacteria morphology and culture | 0-6 | Elective subjects[1] | |
| Forage crops | 2-2 | Plant chemistry | 3-6 | | |
| Soil science | 2-2 | Special field crops | 2-2 | | |
| Elective subjects[1] | | Elective subjects[1] | | | |

The scientific equipment listed further on should be considered as the minimum necessary for the proper functioning of a higher school of agriculture. To adapt it to their own particular syllabus, professors must make such alterations as they consider necessary.

It is obviously indispensable for the school to possess certain additional facilities: a museum containing the various collections indispensable for teaching purposes, a farm, a library, etc. We shall be content to mention these without indicating the cost of their organization which depends on the status which it is desired to give the school. Certain prices are not given in these liste, either because they were unobtainable, or because certain things cannot be evaluated in monetary terms, e.g. collections of samples of feeding stuffs, preserved specimens, films, scale models, etc.

We desire here to thank particularly the directors, rectors, and professors of the following schools: Rijkslandbouwhoogeschool de Gand (State Agronomical Institute) (Belgium), Kongelige Veterinar -og Landbohøjskole (Agricultural College) at Copenhagen (Denmark), Institut national agronomique (National Agronomical Institute-NAI), Ecole supérieure d'application d'agriculture tropicale (Higher Training School for Tropical Agriculture-HTSTA), Ecole nationale d'agriculture (National Agricultural School) at Montpellier, Ecole nationale d'agriculture at Rennes (France), University of Leeds, University of Reading (Great Britain), Landbouwhogeschool (Agricultural University, at Wageningen (Netherlands), Cornell University, N.Y., University of California (U.S.A.), who have so kindly helped us by providing the material on which this publication is based.

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[1] Elective subjects can be chosen from the following: agriculture (0-2), farm machinery (2-2), diseases of field and garden crops (2-6), plant anatomy (3-6), plant genetics (3-2), dairy herd operations (2-2), agricultural marketing (3-0), co-operatives in the economy (3-0), agricultural prices (3-0), national agricultural policies (3-0), introduction to entomology (3-4), farm crops insects (3-0), production and utilization of grain crops (2-2), cereals, grain grading, and marketing (1-6), farm crops skills (0-4), plant competition in field crop production (2-2), determining quality in field crop products (0-8), advanced seed problems (3-0), techniques and principles of plant breeding (2-2), applied plant breeding (2-2), crop improvement, seed production, and marketing (2-2), grassland management (2-2), successful farms (2-4), technical writing (2-0), soil management (3-0), soil physics (2-6), soil fertility and fertilizers (2-2), soil classification and mapping (1-8), soil biochemistry(2-4), nutritional disorders of crops (2-0), introduction to genetics (3-0).

## Origin of the Course Content Sections.

*First Part.* Mathematics (NAI, France), statistical methods applied to biology and agricultural experimental work (HTSTA, France), physics (Great Britain), meteorology and bioclimatology (NAI, France), chemistry and geology (Great Britain), soil science (NAI, France).

*Second Part.* Botany, zoology and bacteriology (Great Britain), genetics (NAI, France).

*Third Part.* Rural electrotechnics, applied mechanics and agricultural water supplies, strength of materials (NAI, France), agricultural engineering in tropical countries (HTSTA, France), rural buildings, general architecture, metallurgy, wood technology, co-operative installations (NAI, France), agricultural machinery (NAS, Rennes, France), agricultural industries (NAI, France), dairying (Ghent, Belgium), œnology (NAS, Montpellier, France), technology of plant products of tropical and sub-tropical origin (HTSTA, France), drawing and topography (NAI, France).

*Fourth Part.* Agriculture in temperate lands (NAS, Rennes, France), agriculture in the tropics, plantation techniques and their effects on tropical soils (HTASTA, France), viticulture (NAS, Montpellier, France), introduction to horticulture, systematic pomology, citriculture, subtropical fruits other than citrus, enzymes (University of California, U. S. A.). Temperate forest economy (NAI, France), tropical forest economy (HTSTA, France), zootechnics (NAI, France), tropical stock raising and zootechnics (HTSTA, France).

*Fifth Part.* Statistics, agricultural land economics, farm management, farm appraisal, farm finance, farmers' co-operatives, food economics, marketing dairy products, marketing poultry eggs and livestock, marketing fruit and vegetables (Cornell University, U.S.A.).

## Principal Sources.

Conference of the Allied Ministers of Education (Science Commission). *Standard Inventories of Basic Scientific Equipment for Teaching Purposes in the Schools, Universities and Technical Colleges of the Liberated Countries of Europe.* London, 1945. Vol. III.

France, Ministère de la France d'outre-mer, Direction de l'agriculture, de l'élevage et des forêts. *Programme des conditions d'admission et de l'enseignement â l'Ecole supérieure d'application d'agriculture tropicale* (Ministry of Overseas Territories, Directorate of Agriculture, Stock Raising and Forests. *Outline of the Conditions of Admission and Teaching at the Higher Training School for Tropical Agriculture.*) Paris, 1946. 26 pp.

International Institute of Agriculture. *Agricultural Education in the World.* Rome, 1935-40. 4 vols.

Institut national agronomique. *Institut national agronomique: son but, son enseignement (The National Agronomical Institute, its aim and teaching).* Paris, 40 pp. English summary, n.d.

Librairie Vuibert. *Programme des conditions d'admission à l'Institut national agronomique (Outline of the conditions of admission to the National Agronomical Institute).* Librairie Vuibert, Paris, 1949. 56 pp.

Michigan State College. *Michigan State College Catalog 1949-1951.* East Lansing (Mich.), 1949. 530 pp.

Minderhoud, G., Sprenger, A. H., Stok, J. E. van der, Wechel, A. te, and the Committee of the Netherlands Institute of Graduates of the Agricultural University College. *The Agricultural, University College.* Wageningen, Netherlands. 22 pp. (mimeo). n.d.

Wageningen. *Wageningen, Centre of Agriculture Science.* The Netherlands, 1948. 44 pp.

## APPARATUS THAT CAN BE USED FOR ALL COURSES

**Demonstration Apparatus.**

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 | Sound film projector, 16 mm, with sound head, rectifier, 110 V, 50 cycles; and the essential ancillary apparatus: amplifier, loud-speaker, group filter, for loud-speaker, pick-up and turntable . . . . . . . | 600.00 |
| 1 | Diascope, projector, objective 62 mm, lamp 250 W, 110 or 220 V . . . . . . . . . | 178.00 |
| 1 | Epidiascope, small type, objective 104 mm, lamp 1 kW, 110 or 220 V . . . . . . . . | 184.00 |
| 1 | Epidiascope for lecture theatre for the combined projection of diapositives and opaque objects; objectives 3.9 f (400 mm) and 4.5 f (250 mm), lamp 500 W, 120 V . | 661.00 |
|  | Total | 1,623.00 |

## FIRST PART

# MATHEMATICAL, PHYSICAL AND CHEMICAL SCIENCES

# MATHEMATICS

Course Content (given only as an example to facilitate the use of the inventories).

(1) *Analysis*: Double and curvilinear integrals. Numericial and finite series. Functions of a complex variable. Fourier series. Linear differential equations of the second order with constant coefficient. (second member constant, sinusoidal or exponential). Example from physics. Equations with partial derivatives. Equation of propagation in three dimensions. Progressive waves, stationary waves.
*Calculation of probabilities:* General ideas of combined analysis. Totally discontinuous probabilities. Partition function. Binomial distribution and its limiting form where $N$ is very large (Gauss' and Poissons' distributions). Continuous probabilities. Study of Gauss' distribution. Variants (partition function and characteristics). Introduction of correlation coefficient.
*Elements of statistics:* Problems and aims. Presentation and reduction of data. Calculation of the mean value, median, quartiles, standard deviation, and central moments. Errors of sampling. Statistical tests (Pearson).

(2) *Aim:* Supplement intended for the course in electrotechnics and strength of materials.
Developments in series. Determinants. Theory of equations. Envelopes. Analytical geometry in space. Spherical trigonometry. Differential calculus. Polar co-ordinates. Applications. Skew curves. Curvature. Osculating plane. Errors. Binomial differentials. Double and triple integrals, curvilinear integrals. Fourier series. Differential equations of higher orders than the first. Simultaneous differential equations. Equations having partial derivatives. Kinematics. Movement of a solid. Relative movement. Coriolis' theorem. Dynamics. Solid bodies, virtual work. Dynamics of systems.

# STATISTICAL METHODS APPLIED TO BIOLOGY AND TO AGRICULTURAL EXPERIMENTAL WORK

A. Course Content (given only as an example to facilitate the use of the inventories).

This course is intended to introduce students to modern statistical methods used in interpreting experimental results. It includes elementary ideas of mathematical statistics and an exposition of the main methods applicable to the problems encountered by biologists and agronomists.

*Elementary ideas of statistical mathematics.*

Elements of the calculation of probabilities. Aleatory variable; law of probability. Characteristics of a law of probability; mean, standard deviation, moments, Pearson's coefficients.

Study of the most generally used probability distribution; Laplace-Gauss or normal distribution, binomial distribution, Poisson's distribution.

Generalities concerning estimation, from a sample, of the characteristics of a probability distribution; accuracy of estimations.

Statistical tests; test derived from the properties of the normal distribution; the Student-Fischer test; Pearson's criterion. Comparison of variances.

Laws of probability with two variables; regression and correlation.

*Applications to biometry.*

Collection and presentation of data obtained from a series of observations (measurements of heights, dimensions, weights, etc. in animal and vegetable population). Graphical representations; histogram.

Practical calculation of the empirical characteristics of an observed distribution (mean, standard deviations, moments). Adjusting observations to a theoretical distribution (Laplace-Gauss, binomial, Poisson's); test of the validity of such an adjustment by Poisson's criterion. Biological conclusions; purity or mixture of populations.

Comparison of two or more samples.

Study of the correlation between two characteristics. Case of qualitative characteristics; contingency tables, independency test. Measurable characteristics; practical calculation of the correlation coefficient, its significance.

*Application of genetics.*

Verifications of the Mendelian hypotheses by Pearson's criterion. Monohybridism, poly-hybridism; case of a group of samples, homogeneity test.

Estimation of percentage of recomination in the case of linked factors (crossing-over); different methods of estimation; their comparison.

*Applications to agricultural experimental work.*

Uncertain factors in experimentation in the field. Attempts at uniformity.

General principles applicable to agricultural experimental work: repetition of trials, chance disposition, control of factors of variation. General method of "analysis of variance".

Study of the principal lay-outs and their statistical interpretation. Blocks; latin square. Brief ideas on inter-actions, and on repetition of experiments in different situations or over several years.

Extension of these methods to experiments concerning animals.

For each of the applications, the students are given duplicated sheets on which several numerical examples are treated in full detail. The students are also given a collection of the principal mathematical tables used in the statistical interpretation.

B. Practical Work.

(1) Calculation of the mean and of the standard deviation of a distribution; adjustment of this distribution to the Laplace-Gauss law; test of the adjustment by Pearson's criterion; comparison of the observed mean with the mean of a second sample.
(2) Application to a problem of genetics.
(3) Interpretation of a field experiment (blocks or latin squares).
(4) Calculation and trial of a correlation coefficient.

C. Equipment (20 students).

*Apparatus necessary for practical work.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 10 | Merchant calculating machines, types 10 FA; capacity 10 × 11 × 20 ×; automatic multiplication and division; electrical . . . . . . . . . | 7,900.00 |

# PHYSICS

A. Course Content (given only as an example to facilitate the use of the inventories).

*General properties of solids, liquids and gases.*

Relations between volume and pressure in gases. Friction and viscosity. Surface tension. Diffusion, osmosis. Stretching of wires. Young's modulus. Elasticity.

*Heat.*

Temperature. Instruments for the measurement of temperature. Expansion of solids, liquids and gases with rise of temperature, isothermal and adiabatic expansion. Quantity of heat. Specific heat. Change of state. Latent heat. Vapour pressure. Boiling point. Dew point. Formation of cloud, fog and dew. Conduction. Thermal conductivity. Convection. Radiation. Newton's law of cooling. Mechanical equivalent of heat. Conservation of energy.

*Sound.*

Production and propagation of sound. Nature of wave motion. Amplitude, wave length, frequency. Velocity of sound in air. Effect of change of temperature on velocity of sound in air, and other gases. Reflection. Determination of frequency by simple methods. Modes of vibration of strings. Sonometer. Vibration of air in pipes. Resonance. Organ pipes. Nodes and antinodes.

*Light.*

Propagation of light. Laws of reflection and refraction. Photometry. Reflection at plane and spherical surfaces. Formation of images. Refraction at plane surfaces and by prisms. Minimum deviation. Chromatic dispersion. General laws of radiation; visible, ultra violet, infra red. Emission and absorption. Heating effects of radiation. Phosphorescence and fluorescence. Formation of images by single lenses. Long and short sight and their correction by lenses. Combination of two lenses to form a simple telescope or microscope. Velocity of light. Polarized light.

*Magnetism and electricity.*

Properties of magnets. Simple phenomena of magnetization. Magnetic fields. Lines of force. Law of magnetic force. Magnetic moment. Intensity of magnetization. The earth as a magnet. Magnetic properties of iron. Laws of the magnetic circuit. Simpler phenomena of electrified bodies. Conduction and insulation. Electrification by friction and induction. Distribution of electrification on conductors. Electric field, strength of field. Law of electric force. Potential capacity, energy of charge. Electroscopes and electrometers. Electric current, magnetic field of current. Magnetic measurement of current. Galvanometers. Work done by electric current. Electromotive force. Difference of potential. Resistance. Ohm's law. Wheatstone's bridge. Potentiometer, resistance of cells. Volt. Ohm. Ampere. Ammeters. Voltmeters. Heating effect of current. Elementary phenomena of electrolysis: Faraday's law. Voltameters. Primary and secondary cells. Action on current circuits in a magnetic field. Electromagnetic induction: Faraday's law. Lenz's law, induction coil. Thermo-electric couple. Simple phenomena of discharge in gases. Elementary modern physics.

B. Laboratory Work.

Specific gravities of solids, powders and liquids.

Hydrometers.
Verification of Boyle's law.
Centres of gravity. Determinations.
Acceleration due to gravity by simple pendulum.
Resonance method for velocity of sound.
Use of sonometer.
Thermometers and determination of fixed points.
Specific heat of solids and liquids.
Latent heats of fusion and vaporization.
Determination of dew point and hygrometric state.
Use of simple photometers.
Focal lengths of mirrors.
Focal length of lenses.
Construction and magnification of microscope and telescope.
Spectrometer.
Refractive indices by simple and total reflection methods.
Mapping magnetic fields.
Comparison of magnetic moments and fields.
Measurements of resistance of wires and cells.
Comparison of E.M.F. using potentiometer.
Measurement of electrochemical equivalent.

C. EQUIPMENT.

See: Volume II (Universities), Physics.

# METEOROLOGY AND BIOCLIMATOLOGY

A. COURSE CONTENT (given only as an example to facilitate the use of the inventories).

(1) Dynamic meteorology and climatology: Variations, diagrams, means.
  Solar radiation: Variations, absorption, measurement.
  Temperature: Of the soil, of water, of the air. Measurement and variations. Isotherms.
  Atmospheric pressure: Measurement. Variations. Isobars. Composition of the atmosphere.
  Winds: Their origin. Centres of high and low pressure. Cyclonic movements. General circulation of the atmosphere. Local winds, seasonal winds.
  Atmospheric disturbances: Barometric depressions. Windstorms, cyclones and anticyclones. Whirlwinds and tornados. Thunderstorms.
  Climates: Their classification. Variability. Microclimates.
  Meteorological observations: Weather forecasting. General principles.

(2) Constituent elements of climates: Study of temperature, precipitation, evaporation and humidity, solar radiation and the light factor. Idea of mean, of extreme, variability, frequency, rhythm and equilibrium. Thermal and water profiles of the air and of the soil: their consequences. Climatic complexes. Climatic syntheses: agro-climatic indices, climatograms.
  Climatic factors and the development of plants: Concept of the ecological or bioclimatic threshold. Concept of sums of temperatures. Complex actions of temperature: thermoperiodism, vernalisation. Concept of heliothermal index and constant, the action factor K. Photoperiodism. Bioclimatic equilibria.

Methods of bioclimatology (experimental ecology). Statistical and experimental methods. Exposition of results obtained in the study of the laws of plant growth as a function of natural climatic complexes.

B. Practical Work.

Study of the classical instruments used for measuring climatic elements: conditions of installation and functioning. Ideas on observations and their analysis.

C. Equipment.

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 | Barometer, mercury | 43.00 |
| 1 | Barometer, recording | 43.00 |
| 1 | Psychometer | 8.50 |
| 1 | Hygrometer, recording | 43.00 |
| 1 | Pyrheliometer | 575.00 |
| 1 | Condensation hygrometer, Alluard | 60.00 |
| 1 | Pluviometer, association | 6.00 |
| 1 | Pluviometer, recording | 86.00 |
| 1 | Thermometer, recording | 43.00 |
| 5 | Thermometers, maximum | 15.00 |
| 5 | Thermometers, minimum | 15.00 |
| 6 | Thermometers for measuring the temperature at different depths in the soil, with equipment | 17.00 |
| 1 | Evaporometer, Piche | 3.00 |
| 1 | Heliograph, Campbell | 86.00 |
| 1 | Solarograph, Gorcynski | 300.00 |
| 1 | Weather vane with recording anemometer | 60.00 |
|  | Total | 1,403.50 |

## CHEMISTRY

A. Course Content (given only as an example to facilitate the use of the inventories).

*General chemistry.*

Methods which led to the discovery of the composition of the commoner materials occurring in nature. History of the discovery of the composition of air and water. Law of chemical combination. Atomic and molecular theories. Equivalent, atomic and molecular weights, the methods of their determination, including those involving atomic heats and isomorphism. Valency. The classification of the elements according to the Periodic System.

Properties of gases and solutions. Thermal dissociation. Osmotic pressure. The colloidal state. Determination of molecular weights in solution by freezing and boiling point methods. Electrolysis and electrolytic dissociation theory. Hydrolysis of salts. Chemical equilibrium and simple examples of the Law of Mass Action. Thermochemistry, exothermic and endothermic reactions. Hess's Law. Combustion and flame. The elementary principles of organic chemistry including elementary ideas of directed valency, of isomerism and the stereoisomerism of carbon; chemical properties as functions of characteristic groups, illustrated by the commoner characteristic groups such as $-OH$, $-COOH$, $-CP$, $-NH_2$.

The history, production, and the properties of the more important and typical elements and their most familiar compounds.

*Soil chemistry.*

The physics and chemistry of rock weathering. Organic matter and humification. Effects of climate and geology on the disposition of soil-forming constituents. The genetic classification of virgin soils.

Soil material. The mineral particles. Mechanical analysis. Mineral colloids. Organic matter, humification and nitrate formation. Soil water. Soil air. Soil temperature.

Cultivation of soils in relation to fertility. The soil and the plant. Soil structure. Mineral plant food. Nitrogenous plant food. Lime status. Soil analysis. Pot experiments. Plot experiments. Classification of cultivated soils.

Cultivation of soils in relation to deterioration and erosion. Conditions of declining fertility. Types of erosion. Soil conservation.

Soil surveys.

Fertilizers and manures. Farmyard manure, composition, chemical and bacteriological changes. Green manuring. Composition and properties of the chief fertilizers, their sources and mode of action. Adaptation to, and relative values on, soils of different types. Methods of analysis; adulteration. Valuation of manures. Crop residues.

*Food chemistry.*

The literature of animal nutrition and dairy science. The composition of the animal body and of the feeding stuffs. Digestion and digestibility. Absorption. Circulation. Respiration and excretion. The metabolism of proteins, carbohydrates and fats. The minerals and vitamins. The methods used in ascertaining the nutritive values of foods and the nutritive requirements of animals. Feeding trials. Comparative slaughter tests. Carbon, nitrogen, energy and mineral balance experiments. Calorimetry, gross, metablisable and nett energy. Starch equivalents. Nett energy values. Feeding standards. The calculation of rations. The feeding stuffs: their classification, manufacture, composition, monetary and manurial value.

Dairy products. Full chemical and physical description of milk; the variation in its composition and the factors influencing this. Preservation and adulteration of milk. Colostrum. Cream. Chemistry of cheese making and cheese ripening. Whey. Theory of butter manufacture. Composition and adulteration of butter. Buttermilk.

*Sprays.*

Composition and properties of the chief materials used in the control of insect and fungus pests. Insecticides, fungicides, sheep dips, etc. Sprays and dusts. Fumigation. Soil sterilization. Seed treatment.

## B. LABORATORY WORK.

The rudiments of qualitative analysis. Easy quantitative operations. Simple volumetric analysis.

The important applications of the following standard solutions: acids an alkalis, potassium permanganate, potassium dichromate, sodium thiosulphate, silver nitrate, potassium thiocyanate.

The action of heat and reagents on well-known substances.

The identification of the products of reaction, including gases.

The preparation and purification of substances using methods involving solution, precipitation, crystallization, distillation and sublimation.

Preparations of sodium thiosulphate, cuprous chloride, sodium cobaltinitrite, cuprammonium sulphate, potassium, chrome alum, etc.

Chemical and physical properties of soils.

The composition of crops.
Nitrification.
Properties of enzymes.
Analysis of manures.
Analysis of feeding stuffs.
Analysis of dairy products.
Analysis of soils.
Analysis of water.
Fungicides.
Insecticides.

C. EQUIPMENT (20 students).

(1) *Laboratory equipment.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 2 | Accumulators, glass case, multiplate 2 V, 60 Ah | 7.00 |
| 2 | Adaptors, Edison screw, electric lamp | .25 |
| 2 | Adaptors, electric lamp, standard bayonet | .25 |
| 1 | Arsenic apparatus, Marsh's complete, 250 cc | 4.00 |
| 1 | Asbestos, Gooch | 2.00 |
| 3 | Augers, soil sampling, with T handle and 4 ft rod, 2" bore | 31.00 |
| 1 | Balance, air damped, analytical, illuminated index, automatic fractions, Oertling, 200 g | 200.00 |
| 4 | Balances, analytical, short beam, 1st quality, 200 g | 528.00 |
| 5 | Balances, analytical, short beam, 2nd quality, 200 g | 500.00 |
| 1 | Balance, Béranger, 7" scale pan, 2 kg | 21.00 |
| 1 | Balance, student's, in case, 250 g | 10.00 |
| 1 | Balance, Westphal, for specific gravity determinations | 24.00 |
| 1 | Barometer, Fortin | 32.00 |
| 30 | Basins, evaporating, fused silica, 3" diam | 23.00 |
| 30 | Basins, fused silica, translucent, 4 ¼ cm diam | 45.00 |
| 6 | Basins, evaporating, FBL, P, 12 cm diam | 3.00 |
| 174 | Basins, evaporating, porcelain, L, from 7 to 16 cm diam | 92.00 |
| 24 | Basins, glass, P, RBL, from 6 to 15 cm diam | 13.00 |
| 1 | Basin, platinum, L, 100 cc | 120.00 |
| 24 | Baths, water, enamelled iron with 2 handles and set of rings, 6" diam | 36.00 |
| 2 | Baths, water, constant level, cooper, multi-aperture, fitted 4 set of rings, gas heated, 16 × 12" | 60.00 |
| 1 | Bath, water, for 6 Soxhlet extraction flasks, 600 W | 68.00 |
| 1 | Bath, water, thermostat controlled, for phosphatase test, gas heated, 12 × 10 × 8" | 69.00 |
| 500 | Beakers, SFL, P, from 33 cc to 4 l | 152.00 |
| 58 | Beakers, TFL, P, from 100 cc to 2 l | 20.00 |
| 14 | Beakers, heavyweight, moulded, Monax, from 2 to 4 l | 24.00 |
| 1 | Bellows, foot, double action, 12" | 16.00 |
| 24 | Blocks, wood, with 12 holes for small tests tubes ½" diam holes | 5.00 |
| 1 | Blowpipe, glassworking, air-gas with detachable jets, 7 jets | 11.00 |
| 1 | Blowpipe, glassworking, oxy-gas | 33.00 |
| 4 | Borers, cork, plated brass, solid handle, set of 12 | 14.00 |
| 72 | Boss heads, retort stand, medium to $^{5}/_{8}$" diam rod | 31.00 |
| 14 | Bottles, aspirator, soda glass, from 500 cc to 15 l | 27.00 |
| 48 | Bottles, dropping, clear glass, 30 cc | 6.00 |
| 12 | Bottles, WM, fitted with 3-hole cork, 5 mm bores, 500 cc | 6.00 |
| 10 | Bottles, gas washing, Dreschel, from 125 to 500 cc | 13.00 |
| 14 | Bottles, NM, flint glass, 5 and 10 l | 81.00 |
| 166 | Bottles, NMFS, flint glass, from ½ to 32 oz | 71.00 |
|  | Carried forward | 2,398.50 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 2,398.50 |
| 32 | Bottles, 40 oz | 10.00 |
| 32 | Bottles, 80 oz | 12.00 |
| 72 | Bottles, water, wash, with cork and bent tubes, P, from 250 to 1,500 cc | 52.00 |
| 2 | Bottles, water, wash, with replaceable top, all glass, 1 l | .50 |
| 72 | Bottles, weighing, outside glass stopper, interchangeable, 2 × 1″ | 24.00 |
| 12 | Bottles, weighing, outside glass stopper, interchangeable, 2 × 1 ¼″ | 5.00 |
| 244 | Bottles, WMBSC, flint glass, from 1 to 40 oz | 28.00 |
| 2 | Bowls, ice, papier mâché, 8″ | 1.00 |
| 18 | Boxes, waste, enamelled iron | 29.00 |
| 36 | Brushes, bottle, ½ and 1 pt | 3.00 |
| 12 | Brushes, burette | 4.00 |
| 24 | Brushes, camel hair, pencil | 1.00 |
| 8 | Brushes, camel hair, flat, ½″ | 1.50 |
| 2 | Brushes, horse hair, flat, 2″ | .50 |
| 48 | Brushes, test tube | 1.00 |
| 8 | Bubblers, acid, soda glass, 4 × 1″ | 3.00 |
| 8 | Bulbs, Kjedahl | 1.00 |
| 60 | Burettes, with stopcock, 50 cc in $^1/_{10}$ cc | 50.00 |
| 2 | Burettes, with stopcock, 100 cc | 4.00 |
| 6 | Burettes, with two-way stopcock, self-filling, 50 cc | 14.00 |
| 2 | Burettes, with two-way stopcock, self-filling, 100 cc | 6.00 |
| 4 | Burners, Batswing, 8″ | 2.00 |
| 48 | Burners, Bunsen, 7: 16″ | 17.00 |
| 12 | Burners, Bunsen, micro, tube $^1/_8$″, height 3″ | 8.00 |
| 4 | Burners, gas, Meker | 14.00 |
| 2 | Burners, ring, small and medium | 2.50 |
| 4 | Burners, steatite (spares for Batswing) | .50 |
| 4 | Calcimeters, Collin's with boxwood slide rule, calculated from sea level | 113.00 |
| 1 set | Capillator, pattern for pH estimation, with selected indicator | 3.50 |
| 1 | Centrifuge, Gerber, for milk testing, electric, 16 tubes | 120.00 |
| 1 | Centrifuge, hand, with bench clamp, to carry 4 × 15 ml tubes, 2,000-3,000 r.p.m. | 7.00 |
| 8 | Chimneys, Bunsen, finned, sheet iron | .50 |
| 18 | Clamps, retort stand, die-cast metal, medium | 17.00 |
| 4 doz | Clamps, retort stand, die-cast metal, for condensers, medium | 72.00 |
| 40 | Clamps, retort stand, iron, medium | 17.00 |
| 12 | Clamps, retort stand, iron, condenser, medium | 14.00 |
| 52 | Clips, screw, hinged, 1 and 1 ½″ | 8.00 |
| 20 | Clips, spring, Mohr's, medium and large | 2.00 |
| 1 | Clock, stop, 6″ dial | 9.00 |
| 2 | Column, fractionating, Vigreux, Pyrex, 8 and 15″ length | 2.50 |
| 1 | Comparator, Lovibond, with discs, for pH of milk, etc. | 60.00 |
| 40 | Condensers, air, soda glass, 18″ | 10.00 |
| 30 | Condensers, double surface, Davies, Monax, P, 10″ | 93.00 |
| 30 | Condensers, double surface, Davies, P, 6″ | 54.00 |
| 18 | Condensers, Liebig, P, 10″ | 15.00 |
| 18 | Connectors, brass, electrical, small, medium and large | 1.50 |
| 6 | Connectors, brass, electrical, with porcelain insulation, single, small | .50 |
| 2 | Connectors, brass, electrical, with porcelain insulation, double, small | .25 |
| 2 | Connectors, brass, electrical, with porcelain insulation, triple, small | .25 |
| | Carried forward | 3,313.00 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 3,313.00 |
| 1 lb | Cord, asbestos, 3 strand, $\frac{1}{8}$ and $\frac{1}{4}$" | 1.00 |
| 242 | Corks, indiarubber, solid, from $\frac{1}{4}$ to 1 $\frac{5}{8}$" | 16.00 |
| 134 | Corks, indiarubber, 1 hole, from $\frac{3}{16}$ to 2 $\frac{1}{4}$" | 23.00 |
| 116 | Corks, indiarubber, 2 holes, from $\frac{1}{4}$ to 2 $\frac{1}{4}$" | 22.00 |
| 27 gross | Corks, wood bark, from $\frac{1}{4}$ to 2 $\frac{1}{2}$" | 48.00 |
| 44 | Corks, wood bark, shive, 3, 3 $\frac{1}{2}$ and 4" | 3.50 |
| 36 | Crucibles, fused silica, 2" | 24.00 |
| 36 | Crucibles, Gooch, porcelain, 3" | 27.00 |
| 8 | Crucibles, nickel, with lid, 35 cc | 6.00 |
| 2 | Crucibles, platinum, thick bottom, with lid, 35 cc | 60.00 |
| 184 | Crucibles, porcelain, TF, with lid | 23.00 |
| 16 | Crucibles, sintered glass, P, 30 cc | 14.00 |
| 1 | Cryoscope, Hortvet's, less thermometers | 29.00 |
| 2 | Desiccators, soda glass, Schleiber, 10" | 14.00 |
| 18 | Desiccators, soda glass, vacuum tubulure with stopcock in lid, 8" | 52.00 |
| 32 | Disks, filter, porcelain, from 12.5 to 23 mm diam | 8.00 |
| 18 | Disks, Gooch, porcelain | 4.00 |
| 40 | Dishes, flat form, fused silica, 7 cm diam | 40.00 |
| 4 doz | Dishes, flat form, porcelain, 8 cm diam | 21.00 |
| 20 doz | Dishes, flat form, nickel, 8 cm diam | 15.00 |
| 5 doz | Dishes, flat form, aluminium, 4 cm diam | 27.00 |
| 48 | Dusters, linen, 20 × 20" | 5.00 |
| 4 | Dusters, string, 22 × 22" | 1.00 |
| 1 | Electrode, calomel, glass, Morton system | 15.00 |
| 1 | Electrode, glass | 11.00 |
| 1 | Electrode, quinhydrone | 6.00 |
| 1 | Epidiascope | 240.00 |
| 30 | Extractors, Soxhlet, P, 55 cc | 30.00 |
| 8 | Files, rat tail, 6" | 1.00 |
| 20 | Files, triangular, glass cutting, 6" | 3.00 |
| 1 pkg | Filter strips, Whatman's for Adams coil, milk test, pkg of 100 | 4.00 |
| 136 | Flasks, conical, NN, P, from 50 to 250 cc | 26.00 |
| 8 doz | Flasks, conical, P, 350 cc | 34.00 |
| 112 | Flasks, conical NN, P, 500 cc and 1 l | 35.00 |
| 48 | Flasks, conical WN, P, from 50 cc to 1 l | 11.00 |
| 72 | Flasks, distillating, P, 25 cc to 3 l | 79.00 |
| 40 | Flask extraction, P, 150 cc | 10.00 |
| 94 | Flasks, FB, P, form 250 cc to 5 l | 39.00 |
| 56 | Flasks, filter, P, form 250 cc to 1 l | 32.00 |
| 186 | Flasks, graduated, single mark, stopped, from 50 cc to 2 l | 157.00 |
| 40 | Flasks, Kjeldahl, P, 300 cc | 30.00 |
| 66 | Flasks, RB, P, from 50 cc to 3 l | 24.00 |
| 1 | Foil, platinum, 6 × 2 × 0.002" | 12.00 |
| 1 | Foil, platinum, 12 × 4 × 0.001" | 24.00 |
| 10 | Funnels, for cream testing, with interchangeable ground joint | 14.00 |
| 40 | Funnels, Bucher, porcelain, 10 and 12 cm | 84.00 |
| 188 | Funnels, filter, soda glass, from 2 to 9" | 40.00 |
| 48 | Funnels, Gooch, soda glass | 5.00 |
| 1 | Funnel, hot filtering, copper, gas heated, for 6" glass funnel | 5.00 |
| 13 | Funnels, separating, cylindrical plain, soda glass, from 100 cc to 1 l | 20.00 |
| 4 | Funnels, thistle, 1 $\frac{1}{2}$" | .50 |
| 1 | Furnace, muffle, gas or electric heating, with pyrometer, 5 × 4 × 9" | 150.00 |
| 1 | Gauze, iron, 1 × 1 yd roll | 3.00 |
| 72 | Gauzes, iron wire, asbestos centre, 6 × 6" | 7.00 |
| 4 | Generators, gas Kipp, 1 l | 26.00 |
| | Carried forward | 4,974.00 |

| Quantity | Item | Total cost in dollar |
|---|---|---|
| | Brought forward | 4,974.00 |
| 112 | Glasses, clock, from 3 to 9" | 10.00 |
| 80 | Glass, cobalt, pieces, 2 × 1" | 4.00 |
| ¼ oz | Glass, microscope, cover, 1 × 1" | .50 |
| 80 | Glasses, watch, 2 and 2 ½" | 3.00 |
| 4 | Holders, lamp, batten, bayonet | 1.00 |
| 4 | Holders, lamp, batten, Edison screw | 1.00 |
| 4 | Holders, lamp, cord grip, bayonet | 1.00 |
| 4 | Holders, lamp, cord grip, Edison screw | 1.00 |
| 48 | Holders, test tube, wood | 3.00 |
| 2 | Hotplates, electric, 14 × 12", 1,500 W | 48.00 |
| 8 | Hotplates, electric, cheap, domestic, 6 × 6", 400 W | 12.00 |
| 10 | Hydrometers, with brass jar, density range 1.025-1.035 g/cc subdivided 0.0002 | 42.00 |
| 1 | Hydrometer, sets of E in case | 12.00 |
| 1 | Hydrometer, sets of 9 accurate | 36.00 |
| 1 | Ice chest, fishmonger type, 3 × 2 × 2" | 45.00 |
| 1 | Jar, aspirator, stoneware for distilled water storage, 10 gal | 14.00 |
| 1 | Jar, bell, with ground flange and 3 tubulures with ground glass joints, 9" diam. | 5.00 |
| 2 | Jars, gas, soda glass, with ground flange, 8 × 2" | .50 |
| 1 | Kettle, domestic, tinned iron, 3 pt. | 1.00 |
| 16 pkgs | Labels, plain, gummed, from 2 × $^1/_8$" to 3 × 2" | 2.00 |
| 1 | Lantern, projection | 76.00 |
| 1 | Level, spirit, 6 × ¾" | 1.00 |
| 1 | Level, spirit, circular, 1 ½" diam | 1.00 |
| 1 | Machine, cork boring | 23.00 |
| 1 | Manometer, vertical, on stand, 80 cm | 5.00 |
| 24 | Mat, beaker, cork composition, 12 cm diam | 4.00 |
| 146 | Measuring cylinder, lipped, from 10 cc to 2 l | 56.00 |
| 1 | Microscope, advanced students' type, 3 objectives, 2 eyepieces, substage condenser and iris diaphragm | 75.00 |
| 2 | Milk scales, Richmond's, size 2 | 4.00 |
| 1 | Mill and runner, with electric meter | 108.00 |
| 1 | Mill, Pulmac, for grinding fibrous materials, without motor | 120.00 |
| 1 set | Model, atomic, balls and springs, in box | 15.00 |
| 1 | Molecular weight apparatus, Beckmann, freezing point method, complete with thermometer | 39.00 |
| 2 | Mortars and pestles, agate, 2" | 7.00 |
| 1 | Mortar and pestle, iron, bell shape | 1.00 |
| 20 | Mortars and pestles, porcelain, white glazed, 4" | 10.00 |
| 3 | Mortars and pestles, Wedgwood, 6 and 9" | 9.00 |
| 1 | Mortar and pestle, wood, for soils, 14" diam | 6.00 |
| 1 | Motor, electric mains, universal, $^1/_{16}$ HP, 2,000 r.p.m. | 12.50 |
| 1 | Motor, electric mains, universal, $^1/_8$ HP, 2,000 r.p.m. | 16.50 |
| 10 sets | Nessler cylinders, 6 in set, matched, 100 cc | 40.00 |
| 2 | Ovens, hot air, copper, gas or electric heating, 12 × 12 × 12" | 60.00 |
| 1 | Oven, steam, copper, gas or electric heating, 4 compartments, each 10 × 10 × 10" | 116.00 |
| 4 | Palette knives, stainless steel, 4" blade | 3.00 |
| 1 sheet | Paper, asbestos | .50 |
| 250 boxes | Paper, filter, Whatman, No. 1, from 5 to 25 cm | 79.00 |
| 3 boxes | Paper, filter, Whatman, No. 1, in sheets, 12 per box, 18 × 22" | 8.00 |
| 60 boxes | Paper, filter, Whatman, No. 40, from 5 to 12.5 cm | 72.00 |
| 96 boxes | Paper, filter, Whatman, No. 42, from 5.5 to 12.5 cm | 116.00 |
| 78 boxes | Paper, filter, Whatman, No. 50, from 5.5 to 12.5 cm | 116.00 |
| 54 boxes | Paper, filter, Whatman, No. 541, from 7 to 11 cm | 48.00 |
| 36 sheets | Paper, glazed, black, 20 × 20" | 1.00 |
| | Carried forward | 6,464.50 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 6,464.50 |
| 36 sheets | Paper, glazed, yellow, 20 × 20″ | 1.00 |
| 60 books | Paper, test, litmus, blue | 2.00 |
| 60 books | Paper, test, litmus, red | 2.00 |
| 1 | pH meter, direct reading | 195.00 |
| 1 | Pipette, automatic, 1 cc | 2.00 |
| 120 | Pipettes, graduated, 1 cc in $^{1}/_{100}$ cc to 10 cc in $^{1}/_{10}$ cc | 46.00 |
| 1 | Pipette, automatic, 10 cc | 2.50 |
| 144 | Pipettes, graduated, single mark, from 5 to 100 cc | 59.00 |
| 10 | Pipettes, long stem, 20 cc | 3.00 |
| 12 | Plates, ground glass, gas jar cover, 3″ | .50 |
| 24 | Plates, porcelain, circular, with rim to hold bottles of conc. acid, 12.5 cm | 8.00 |
| 30 | Plates, porcelain, desiccator | 135.00 |
| 24 | Plates, porcelain, rectangular, with rim, to hold bottles of conc. acid, 27 × 9 cm | 22.00 |
| 1 | Polarimeter, half shadow, with tubes, 10 and 20 cm | 360.00 |
| | Polenski distillation apparatus: | |
| 30 | Flasks, 300 cc | 11.00 |
| 20 | Condensers | 27.00 |
| 20 | Still heads | 12.00 |
| 20 | Receivers | 13.00 |
| 20 | Asbestos discs | 9.00 |
| 72 | Policemen, stirrer, rubber, ¼″ | 4.00 |
| 1 | Potentiometer | 132.00 |
| 1 | Presser, cork, rotary, iron | 2.00 |
| 20 | Pumps, filter, soda glass | 15.00 |
| 1 | Refractometer, Abbé | 280.00 |
| 1 | Refrigerator, gas-electric-paraffin driven as required, 4 ft$^3$ | 210.00 |
| 48 | Rings, retort stand, iron, 3″ | 13.00 |
| 24 | Rings, retort stand, iron, 5″ | 8.00 |
| 11 lb | Rods, P, from 3 to 7 mm | 7.50 |
| 22 lb | Rods, soda glass, from 2 to 7 mm | 10.00 |
| 72 | Rods, stirring, soda glass, 6 × ¼″ | 3.00 |
| 36 | Rubbers, for Gooch crucibles, No. 3 | 7.00 |
| 1 | Shaker, electric, reciprocal to take 2 bottles | 96.00 |
| 1 | Shaker, electric, rotary, to take 4 bottles | 105.00 |
| 1 | Sharpener, cork borer | 1.00 |
| 2 | Shelves, beehive, stoneware, 3″ | 1.00 |
| 1 | Sieve, brass; 4 cm deep, 8 cm diam | 10.00 |
| 1 set | Sieves, brass wire, with lids and receivers, set of 11, 6″ diam, 20/200 mesh | 12.00 |
| 36 | Slides, microscope, glass, cavity, 3 × 1″ | .50 |
| 72 | Slides, microscope, glass, plain 3 × 1″ | 1.00 |
| 1 | " Sparklet " siphon, with 2 gross carbon dioxide bulbs | 19.00 |
| 48 | Spatulas, bone, double end, 10 cm | 4.00 |
| 20 | Spatulas, nickel, double end, 11 cm | 7.00 |
| 12 | Spatulas, nickel, spoon at one end, 12 cm | 4.00 |
| 12 | Spatulas, porcelain, spoon at one end, 12 cm | 2.00 |
| 30 | Splash hand, Kjedahl, P | 21.00 |
| 30 | Spreaders, bunsen, rose, brass | 9.00 |
| 60 | Stands, burette, wood, double clip | 50.00 |
| 36 | Stands, filter, wood, double ring | 32.00 |
| 6 | Stands, pipette, wood, for 12 pipettes | 11.00 |
| 82 | Stands, retort, iron, from 18 to 36″ rod | 63.00 |
| 36 | Stands, test tube, wood, 12 holes and pegs | 32.00 |
| 1 | Stand, digestion, for 6 Kjeldahl flasks | 11.00 |
| 30 | Stands, tripod, iron, circular top, 6″ diam | 9.00 |
| 40 | Stands, tripod, iron, triangular top, 6 × 6 × 6″ | 12.00 |
| 1 | Still, water, steam-gas-electric heating, 6 l per h | 192.00 |
| | Carried forward | 8,770.50 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 8,770.50 |
| 1 | Stirrer, air-turbine, all plastic, $^{1}/_{75}$ HP | 27.00 |
| 1 | Stirrer, electric, with speed control, $^{1}/_{30}$ HP | 30.00 |
| 4 | Stopcocks, oblique, P, 2 and 5 mm bore | 6.00 |
| 4 | Stopcocks, oblique, T, 3 way, P, 2 and 5 mm bore | 6.00 |
| 8 | Stopcocks, oblique, soda glass, 2 and 5 mm bore | 10.00 |
| 8 | Stopcocks, oblique, T, 3 way, soda glass, 2 and 5 mm bore | 11.00 |
| 28 | Stopcocks, straight, P, from 1 to 10 mm bore | 43.00 |
| 24 | Stopcocks, straight, soda glass, from 1 to 5 mm bore | 24.00 |
| 1 | Tank, distilled water storage, cylindrical, aluminium, 10 gal | 28.00 |
| 4 rolls | Tape, insulating, ½ and ¾" wide | 8.00 |
| 12 | Teats, indiarubber, red, medium | 1.00 |
| 4 | Thermometers, mercury, solid stem, —30 to 50° C | 6.00 |
| 1 set | Thermometers, mercury, solid stem, set of 5, —10 to 250° C | 21.00 |
| 24 | Thermometers, mercury, solid stem, nitrogen filled, 0 to 110° C | 18.00 |
| 12 | Thermometers, mercury, solid stem, nitrogen filled, 0 to 250° C | 11.00 |
| 2 | Thermometers, mercury, solid stem, nitrogen filled, 0 to 360° C | 3.00 |
| 1 | Thermostat, complete with controls, for use with refractometer, electrically driven pump, enclosed, 12 × 12 × 12" | 150.00 |
| 1 | Thermostat, copper bath, complete with controls and cooling coil, 12 × 12 × 12" | 60.00 |
| 2 boxes | Thimbles, Soxhlet, Whatman, double thickness, 22 × 88 mm | 9.00 |
| 2 boxes | Thimbles, Soxhlet, Whatman, double thickness, 26 × 60 mm | 9.50 |
| 24 | Tiles, porcelain, glazed, white, 6 × 6" | 7.00 |
| 18 | Tiles, porous | 3.00 |
| 1 | Tintometer, Lovibond, No. 1, complete with 60 red, yellow and blue slides, 12 neutral tint slides and glass cell | 106.00 |
| 24 | Tongs, crucible, brass, bowed, 8" | 22.00 |
| 1 set | Tools, glassblowers, set of 12 assort. | 6.00 |
| 18 | T pieces, soda glass, 5 mm bore | 2.00 |
| 18 | Trays, enamelled iron, for soil drying, 20 × 6 × 2" | 60.00 |
| 24 | Trays, enamelled iron, for soil drying, 8 × 5 × 2" | 36.00 |
| 56 | Trays, sand, iron, 6 and 9" | 8.00 |
| 48 | Triangles, crucible, pipeclay, 2" | 1.00 |
| 1 | Trough, pneumatic, stoneware, 10" | 2.00 |
| 18 | Tubes, centrifuge Gerber, for whole milk, with rubber stopper to fit | 13.00 |
| 18 | Tubes, centrifuge Gerber, for separated milk, with rubber stopper | 26.00 |
| 18 | Tubes, centrifuge Gerber, for cheese, with rubber stopper | 19.00 |
| 18 | Tubes, Rose-Gottlieb, for fat in milk estimation | 29.00 |
| 18 | Tubes, Stoke's for fat in milk estimation, 50 cc | 14.00 |
| 4 | Tubes, drying, calcium chloride, straight, soda glass, 4" | .25 |
| 78 | Tubes, ignition, hard glass, 2 × ¼" and 3 × $^{3}/_{8}$" | 3.00 |
| 306 | Tubes, specimen, FB, corked, from 2 × ¼" to 4 × 1" | 11.00 |
| 5 gross | Tubes, test, P, from 5 × $^{3}/_{8}$" to 7 × 1 ¼" | 30.00 |
| 9 gross | Tubes, test, soda glass, 6 × ¾" and 4 × ½" | 15.00 |
| ½ gross | Tubes, test, rimless with mark at 10 ml for phosphatase test with rubber stopper, 6 × $^{5}/_{8}$" | 9.00 |
| 8 | Tubes, U, calcium chloride, 4 and 6" | 1.00 |
| 8 | Tubes, U, calcium chloride, stoppered with side arm, 4 × ½" | 5.00 |
| 4 lb | Tubing, capillary, P, from 0.5 to 2 mm bore | 2.00 |
| 3 lb | Tubing, capillary, soda glass, 0.5 and 1 mm bore | 1.50 |
| 125 ft | Tubing, indiarubber, seamless, from $^{3}/_{16}$ to ¾" | 35.00 |
| | Carried forward | 9,718.75 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 9,718.75 |
| 75 ft | Tubing, indiarubber, seamless, press., from $^{1}/_{8} \times ^{3}/_{8}''$ to $^{3}/_{8} \times 1''$ | 43.00 |
| 23 | Tubing, P, from 1 to 25 mm bore | 38.00 |
| 83 | Tubing, soda glass, from 1 to 50 mm bore | 30.00 |
| | Universal motor, combined ammeter, voltmeter, ohmmeter | |
| 1 | AVO minor | 12.00 |
| 1 | AVO major | 48.00 |
| 24 sheets | Uralite, 12″ × 12″ × $^{3}/_{16}''$ | 4.00 |
| 1 sheet | Uralite, 6 × 6 ½″ | 1.00 |
| 1 box | Weights, analytical, 1st quality, stainless steel, NPL, " A " tolerance, 0-100 g × 1 mg | 13.50 |
| 20 boxes | Weights, analytical, 2nd quality, stainless steel or plated brass, NPL, " B " tolerance, 0-100 g × 1 mg | 228.00 |
| 1 box | Weights, analytical, stainless steel, 0-100 g × 1 mg | 23.50 |
| 2 boxes | Weights, physical, brass plated, in box, 1 kg × 1 g | 12.50 |
| 2 boxes | Weights, students', brass plated, 0-200 g × 0.01 g | .50 |
| 2 ½ lb | Wire, cooper, bare, from 14 to 22 SWG | 1.50 |
| 1 ½ lb | Wire, cooper, DCC, from 18 to 22 SWG | 1.00 |
| 36 yd | Wire, flexible, twin, 5 and 10 a | 2.00 |
| 3 ft | Wire, platinum, 0.012″ diam | 3.00 |
| 1 ft | Wire, platinum, 0.020″ diam | 2.00 |
| 2 lb | Wool, cotton | .50 |
| 2 lb | Wool, glass, in packets ¼ lb | 3.50 |
| | Total | 10,186.25 |

(2) *Chemicals* (20 students)—(annual consumption).

(*a*) Inorganic.

| | | |
|---|---|---|
| 3 winch | Acid, acetic, glacial, pure | 7.00 |
| 1 winch | Acid, acetic, glacial, AR | 3.00 |
| ¼ lb | Acid, arsenic, pure | .50 |
| 1 lb | Acid, arsenious, pure | .50 |
| ½ lb | Acid, boric, powdered, pure | .25 |
| 1 lb | Acid, boric, powdered, AR | .25 |
| 2 lb | Acid, chromic, comml | 1.00 |
| 2 lb | Acid, chromic, cryst, pure | 2.00 |
| 6 winch | Acid, hydrochloric, conc, comml | 2.00 |
| 10 winch | Acid, hydrochloric, conc, pure | 8.00 |
| 2 winch | Acid, hydrochloric, conc, AR | 2.00 |
| 2 lb | Acid, hydrofluoric, redistilled, 40% | .50 |
| 3 oz | Acid, molybdic, anhydrous, 40% | .50 |
| 4 winch | Acid, nitric, conc, comml | 4.00 |
| 6 winch | Acid, nitric, conc, pure | 7.00 |
| 2 winch | Acid, nitric, conc, AR | 6.00 |
| 2 lb | Acid, oxalic, cryst, pure | .50 |
| 2 lb | Acid, oxalic, AR | 2.00 |
| 3 lb | Acid, perchloric, 60-70% | 7.00 |
| ¼ lb | Acid, phosphomolybdic | 1.00 |
| 3 lb | Acid, phosphoric, syrupy | 1.00 |
| 1 lb | Acid, phosphoric, syrupy, AR | 1.00 |
| ½ lb | Acid, picric, cryst., pure | 1.00 |
| ½ lb | Acid, pyrogallic, resublimed, pure | 2.00 |
| 4 winch | Acid, sulphuric, conc, comml | 2.00 |
| 8 winch | Acid, sulphuric, conc, pure | 9.00 |
| 2 winch | Acid, sulphuric, conc, AR | 4.00 |
| 2 syphons | Acid, sulphurous | 6.00 |
| 2 oz | Acid, tungstic, yellow | .25 |
| | Carried forward | 81.25 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 81.25 |
| 1 lb | Agar-agar, powdered | 2.00 |
| 1 lb | Albumen, egg | 1.00 |
| ½ lb | Aluminium oxide, activated, pure, chromatographic | 2.00 |
| ½ lb | Aluminium oxide, powdered, pure | 1.00 |
| 1 lb | Aluminium sulphate, crystalline | .50 |
| 4 winch | Ammonia, d=0.880 | 4.00 |
| 2 winch | Ammonia, d=0.880, AR | 10.00 |
| 2 lb | Ammonium bicarbonate, pure | 1.00 |
| 2 lb | Ammonium carbonate, lump, pure | .50 |
| ½ lb | Ammonium carbonate, lump AR | .25 |
| 5 lb | Ammonium chloride, powdered, comml | 1.00 |
| 3 lb | Ammonium chloride, powdered, pure | 1.00 |
| 2 lb | Ammonium chloride, powdered, AR | 1.00 |
| 5 lb | Ammonium molybdate, powdered, pure | 10.00 |
| 7 lb | Ammonium nitrate, cryst, pure | 2.00 |
| ½ lb | Ammonium phosphate, cryst, pure | 1.00 |
| 2 lb | Ammonium sulphate, recryst, pure | .50 |
| 3 winch | Ammonium sulphide, soln | 3.00 |
| ½ lb | Ammonium sulphocyanide, cryst, pure | .25 |
| ¼ lb | Ammonium sulphocyanide, cryst, AR | .25 |
| ¼ lb | Antimony trichloride, cryst, pure | .25 |
| ¼ lb | Antimony trioxyde, cryst, pure | .25 |
| ¼ lb | Arsenic pentoxide, pure | 1.00 |
| 1 lb | Asbestos, Gooch | 1.00 |
| ¼ lb | Asbestos, woolly | .50 |
| 1 lb | Barium carbonate, pptd, pure | .25 |
| 2 lb | Barium chloride, cryst, pure | 1.00 |
| 2 lb | Barium chloride, cryst, AR | 1.00 |
| 4 lb | Barium hydroxide, cryst, pure | 2.00 |
| 2 lb | Barium hydroxide, cryst, AR | 1.00 |
| ½ lb | Barium nitrate, cryst, AR | .25 |
| ½ lb | Barium sulphate, pptd, pure | .25 |
| ½ lb | Bismuth carbonate, pure | 2.00 |
| 2 lb | Borax, powdered | .25 |
| 2 lb | Borax, powdered, AR | 1.00 |
| ½ lb | Bromine, pure | .50 |
| 1 lb | Cadmium chloride, cryst, pure | 2.00 |
| 5 lb | Calcium carbonate, pptd, light | .50 |
| 1 lb | Calcium carbonate, Iceland spar | 1.00 |
| 7 lb | Calcium chloride, anhydrous, lump, comml | 1.00 |
| 5 lb | Calcium chloride, anhydrous, pure | 1.00 |
| 5 lb | Calcium cyanamide, comml | .50 |
| ½ lb | Calcium fluoride, powdered, pure | .25 |
| ¼ lb | Calcium nitrate, cryst, pure | .25 |
| 5 lb | Calcium oxide, powdered, pure | 1.00 |
| 5 lb | Calcium oxide, lump, ex marble | 1.00 |
| 1 lb | Calcium sulphate, pptd, pure | .25 |
| 1 winch | Carbon disulphide, pure | 3.00 |
| ¼ lb | Chromium alum., cryst, pure | .25 |
| 5 lb | Charcoal, animal, powdered | 1.00 |
| 2 lb | Charcoal, wood, powdered | .25 |
| ½ lb | Cobalt nitrate, pure | 1.00 |
| ½ lb | Copper foil | .25 |
| 2 lb | Copper turnings | 2.00 |
| ½ lb | Copper acetate, pure | .50 |
| ¼ lb | Copper carbonate, pure | .25 |
| ¼ lb | Copper chloride, cupric, pure | .25 |
| 2 lb | Copper chloride, cuprous, pure | 3.00 |
| ½ lb | Copper nitrate, pure | .25 |
| ¼ lb | Copper oxide, powdered | .25 |
| | Carried forward | 157.00 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 157.00 |
| ½ lb | Copper oxide, from wire | .50 |
| 5 lb | Copper sulphate, cryst, pure | 1.00 |
| 4 lb | Copper sulphate, cryst, AR | 2.00 |
| ½ lb | Fusion mixture, powdered, pure | .25 |
| 3 winch | Hydrogen peroxyde, soln, 100 vol | 4.00 |
| ½ lb | Hydroxylamine hydrochlorine, cryst, pure | 4.00 |
| ¼ lb | α-Hydroxyquinoline | 4.00 |
| 1 lb | Iodine, resublimed, pure | 3.00 |
| 1 lb | Iodine, resublimed, AR | 4.00 |
| 1 lb | Iron filings | .25 |
| 4 reals | Iron wire, 35 SWG | 1.00 |
| ½ lb | Iron alun, ferric | .25 |
| 1 lb | Iron ammonium sulphate, cryst, AR | .25 |
| ½ lb | Iron ammonium sulphate, cryst, pure | .25 |
| 2 lb | Iron, perchloride, pure | .50 |
| 1 lb | Iron oxide, ferric, powdered, pure | .50 |
| ½ lb | Iron phosphate, ferric, pure | .50 |
| 5 lb | Iron sulphate, ferrous, cryst, pure | .50 |
| 7 lb | Iron sulphide | 1.00 |
| 5 lb | Lead acetate, cryst, pure | 2.00 |
| 1 lb | Lead acetate, cryst, AR | .50 |
| ½ lb | Lead carbonate, pptd, pure | .25 |
| ½ lb | Lead chromate, powdered, pure | .25 |
| 1 lb | Lead nitrate, cryst, pure | .50 |
| ½ lb | Lead oxide, otharge, pure | .25 |
| 2 lb | Lead oxide, red, pure | 1.00 |
| ½ lb | Lithium carbonate, pure | 2.00 |
| 1 lb | Litmus, blue, gran, pure | 2.00 |
| 2 oz | Magnesium metal, ribbon | 1.00 |
| ¼ lb | Magnesium metal, powder | 1.00 |
| ½ lb | Magnesium carbonate, heavy | .25 |
| 1 lb | Magnesium chloride, cryst, pure | .25 |
| ¼ lb | Magnesium nitrate, pure | .25 |
| ½ lb | Magnesium oxide, light, pure | .25 |
| ½ lb | Magnesium oxide, heavy, pure | .50 |
| 5 lb | Manganese dioxide, small lumps | 7.00 |
| 2 lb | Manganese dioxide, powdered | 3.00 |
| ½ lb | Manganese sulphate, cryst | .25 |
| 7 lb | Marble chips | .50 |
| 7 lb | Mercury metal | 10.00 |
| 1 lb | Mercury, chloride, mercuric, pure | 2.00 |
| ¼ lb | Mercury, chloride, mercurous | .50 |
| ½ lb | Mercury iodide, mercuric, red, pure | 2.00 |
| ½ lb | Mercury oxide, mercuric, red | 1.00 |
| 1 lb | Mercury sulphate, mercuric | 2.00 |
| ½ lb | Microcosmic salt, pure | .25 |
| ¼ lb | Nickel chloride, dry, pure | .25 |
| ¼ lb | Nickel sulphate, cryst, pure | 1.00 |
| ¼ lb | Phosphorus, red, amorphous | .50 |
| ¼ lb | Phosphorus, yellow, stick | .25 |
| 1 lb | Phosphorus pentoxide, pure | 1.00 |
| 10 ft | Platinum wire, 0.012″ diam | 12.00 |
| 36 in² | Platinum foil, 0.011″ thick | 30.00 |
| 4 g | Platinum chloride, solid | 8.00 |
| ½ lb | Potassium acetate, anhydrous, pure | .25 |
| 1 lb | Potassium bicarbonate, pure | .25 |
| ½ lb | Potassium bisulphate, fused, pure | .25 |
| ½ lb | Potassium bromide, cryst, pure | .25 |
| ¼ lb | Potassium bromide, cryst, AR | .25 |
| | Carried forward | 279.75 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 279·75 |
| ½ lb | Potassium carbonate, anhydrous, pure | ·25 |
| 5 lb | Potassium chlorate, cryst, pure | 2.00 |
| 7 lb | Potassium chloride, cryst, pure | 2.00 |
| 1 lb | Potassium chromate, cryst, pure | ·50 |
| ½ lb | Potassium chromate, cryst, AR | ·50 |
| 1 lb | Potassium cyanide, 90-95% | 1.00 |
| 1 lb | Potassium cyanide, AR | 3.00 |
| 5 lb | Potassium dichromate, cryst, pure | 2.00 |
| 2 lb | Potassium dichromate, cryst, AR | 1.00 |
| 1 lb | Potassium ferricyanide, cryst, pure | 1.00 |
| ¼ lb | Potassium ferricyanide, cryst, AR | ·50 |
| 2 lb | Potassium ferrocyanide, cryst, pure | 1.00 |
| 1 lb | Potassium ferrocyanide, AR | 1.00 |
| 6 lb | Potassium hydroxide, pellets, pure | 6.00 |
| 3 lb | Potassium hydroxide, pellets, AR | 4.00 |
| ¼ lb | Potassium iodate | 1.00 |
| 5 lb | Potassium iodide, cryst, pure | 12.00 |
| 1 lb | Potassium iodide, cryst, AR | 4.00 |
| 2 lb | Potassium metamisulphite, powdered, pure | 1.00 |
| 5 lb | Potassium nitrate, cryst, pure | 2.00 |
| 2 lb | Potassium nitrite, cryst, pure | 3.00 |
| 5 lb | Potassium permanganate, cryst, pure | 2.00 |
| 3 lb | Potassium permanganate, cryst, pure, AR | 3.00 |
| 5 lb | Potassium sulphate, cryst, pure | 2.00 |
| ½ lb | Potassium thiocyanate, cryst, pure | ·50 |
| ½ lb | Potassium thiocyanate, cryst, AR | 1.00 |
| 1 lb | Pumice, lump | ·25 |
| 1 lb | Pumice, 8-20 mesh | ·25 |
| 1 gal | Sand, silver, Calais | ·25 |
| ½ lb | Semicarbazide hydrochloride | 4.00 |
| ½ lb | Silica, pptd, pure | ·25 |
| ½ lb | Silica gel, white | 1.00 |
| 2 lb | Silica gel, tell-tale | 2.00 |
| 5 lb | Silver nitrate, cryst, AR | 60.00 |
| ¼ lb | Quinhydrone | 3.00 |
| 1 winch | Soap soln, Wanklyn's | 3.00 |
| 1 lb | Sodium metal, pure | 1.00 |
| 2 lb | Sodium acetate, cryst, pure | ·50 |
| 2 lb | Sodium acetate, ahnydrous, fused | 1.00 |
| 1 lb | Sodium arsenate, cryst, pure | 1.00 |
| 1 lb | Sodium arsenite, pure | 1.00 |
| 4 lb | Sodium bicarbonate, pure | ·50 |
| 1 lb | Sodium bicarbonate, AR | ·25 |
| 1 lb | Sodium bisulphate, fused | ·50 |
| 4 lb | Sodium bisulphite, pure | 1.00 |
| ½ lb | Sodium borate | ·25 |
| ½ lb | Sodium bromide | ·50 |
| 7 lb | Sodium carbonate, cryst | 1.00 |
| 6 lb | Sodium carbonate, anhydrous | 2.00 |
| 2 lb | Sodium carbonate, anhydrous, AR | 1.00 |
| ½ lb | Sodium chlorate, cryst, pure | ·50 |
| 3 lb | Sodium chloride, cryst, pure | ·25 |
| 2 lb | Sodium chloride, cryst, AR | 1.00 |
| ½ lb | Sodium chromate, pure | ·75 |
| 1 winch | Sodium cobaltnitrite, soln | 6.00 |
| 1 lb | Sodium cobaltnitrite, solid | 5.00 |
| ¼ lb | Sodium cyanate, pure | 2.00 |
| ¼ lb | Sodium cyanide, pure | ·50 |
| 1 lb | Sodium dichromate, cryst, pure | ·25 |
| | Carried forward | 438·75 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 438.75 |
| ½ lb | Sodium fluoride, pure | 1.00 |
| ½ lb | Sodium formate, dry, pure | .25 |
| 2 lb | Sodium hydrosulphite | 1.00 |
| 48 lb | Sodium hydroxide, powdered, comml | 5.00 |
| 8 lb | Sodium hydroxide, pellets, pure | 6.00 |
| 8 lb | Sodium hydroxide, pellets, AR | 8.00 |
| ¼ lb | Sodium iodate, pure | 1.00 |
| ¼ lb | Sodium iodide | 1.00 |
| ¼ lb | Sodium molybdate | 1.00 |
| 7 lb | Sodium nitrate, cryst, pure | 2.00 |
| 1 lb | Sodium nitrate, cryst, AR | 1.00 |
| 5 lb | Sodium nitrite, cryst, pure | 3.00 |
| 1 lb | Sodium nitrite, cryst. AR | 1.00 |
| 2 oz | Sodium nitroprusside, pure | .50 |
| 2 lb | Sodium oxalate, AR | 3.00 |
| 1 lb | Sodium perchlorate, pure | 1.00 |
| ½ lb | Sodium potassium tartrate, cryst, pure | .25 |
| ½ lb | Sodium hydrogen phosphate, Sorensen's salt | 1.00 |
| 1 lb | Sodium silicate, soln | .25 |
| 1 lb | Sodium sulphate, cryst, pure | .25 |
| 2 lb | Sodium sulphate anhydrous, pure | 1.00 |
| 2 lb | Sodium sulphide, cryst, pure | 1.00 |
| 3 lb | Sodium sulphite, cryst, pure | .50 |
| 5 lb | Sodium thiosulphate, cryst, pure | 1.00 |
| 2 lb | Sodium thiosulphate, cryst, AR | 1.00 |
| ¼ lb | Sodium tungstate, pure | .25 |
| 4 lb | Soda lime | 1.00 |
| 3 lb | Sofnolite | 3.00 |
| 2 lb | Starch, potato | .25 |
| 2 lb | Starch, soluble, Lintner's | 2.00 |
| ½ lb | Strontium carbonate, pptd, pure | .25 |
| ½ lb | Strontium nitrate, cryst, pure | .25 |
| 2 lb | Sulphur, flowers | .25 |
| 2 lb | Sulphur, roll | .25 |
| ¼ lb | Tin, metal, foil | .25 |
| 2 lb | Tin, metal, gran | 3.00 |
| 6 lb | Tin, chloride, stannous, pure | 6.00 |
| ¼ lb | Uranium acetate, pure | 1.00 |
| 1 lb | Vaseline, yellow, pure | 1.00 |
| ½ lb | Vaseline, white | .25 |
| 4 lb | Wax, paraffin, white, mp 60° C | 1.00 |
| 1 lb | Zinc, metal, dust | .25 |
| 7 lb | Zinc, metal, gran | 3.00 |
| 1 lb | Zinc, metal, sticks, forensic | 1.00 |
| ½ lb | Zinc, acetate, pure | .25 |
| ½ lb | Zinc, carbonate, pure | .25 |
| ½ lb | Zinc, chloride, fused sticks | .25 |
| ½ lb | Zinc, nitrate, pure | .25 |
| 1 lb | Zinc, oxide | .25 |
| ½ lb | Zinc, sulphate, cryst, pure | .25 |
| | Total | 506.50 |

(*b*) Organic.

| | | |
|---|---|---|
| 2 oz | Acid, aminoacetic | 4.00 |
| 1 lb | Acid, benzoic, synthetic, pure | 1.00 |
| ¼ lb | Acid, n-butyric, pure | 3.00 |
| ¼ lb | Acid, carbolic, pure | .25 |
| | Carried forward | 8.25 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 8.25 |
| ¼ lb | Acid, chloroacetic | .50 |
| 7 lb | Acid, citric | 3.00 |
| ¼ lb | Acid, formic, d = 1.2 | .50 |
| ½ lb | Acid, lactic | .50 |
| 2 lb | Acid, oleic, pure | 2.00 |
| 2 lb | Acid, palmitic | 3.00 |
| ¼ lb | Acid, propionic | 2.00 |
| ¼ lb | Acid, propionic, anhydrous | 2.00 |
| 1 lb | Acid, salicylic, synthetic, pure | 1.00 |
| 2 lb | Acid, stearic, pure | 3.00 |
| ¼ lb | Acid, succinic, cryst, AR | 1.00 |
| ¼ lb | Acid, tannic | 1.00 |
| 3 lb | Acid, tartaric, cryst | 2.00 |
| 1 lb | Acetaldehyde, pure | 3.00 |
| 1 lb | Acetamide, pure | 3.00 |
| 1 lb | Acetic ether, pure | 1.00 |
| 4 winch | Acetone, rectified | 6.00 |
| 4 lb | Alcohol, amyl., tertiary, tech | 16.00 |
| 11 gal | Alcohol, ethyl, methylated spirit | 7.00 |
| 4 gal | Alcohol, ethyl, absolute | 6.00 |
| 4 gal | Alcohol, methyl | 5.00 |
| ½ lb | Alumina, chromatographic | 2.00 |
| 1 lb | Amyl acetate, pure | 1.00 |
| 1 winch | Aniline pure | 4.00 |
| 1 winch | Benzaldehyde | 5.00 |
| 4 winch | Benzene, cristallizable | 5.00 |
| 2 winch | Carbon tetrochloride, pure | 4.00 |
| ¼ lb | Chloral hydrate | .25 |
| 1 winch | Chloroform | 6.00 |
| ½ lb | Collodion acetone | .50 |
| 2 lb | Dextrone, anhydrous, powdered | 1.00 |
| 8 winch | Ether, d = 0.73 | 8.00 |
| 4 lb | Ethyl acetate | 4.00 |
| 1 lb | Ethyl oxalate, pure | 2.00 |
| ½ lb | Ethylene, dibromide, pure | 1.00 |
| ½ lb | Ethylene, glycol, pure | .50 |
| 1 winch | Formaldehyde | 1.00 |
| 2 oz | Furfural | .50 |
| ¼ lb | Gelatine, sheets | .25 |
| 1 winch | Glycerol | 3.00 |
| 2 oz | Glycine | 1.00 |
| 2 oz | Inulin | 1.00 |
| 2 oz | Iodoform, cryst | .50 |
| ½ lb | Kaolin | .25 |
| ½ lb | Kieselguhr | .25 |
| 1 lb | Lactose | .25 |
| 1 lb | Levulose | 4.00 |
| 2 oz | Magenta | .50 |
| ¼ lb | Maltose | 2.00 |
| ¼ lb | Methylamine, 33% soln | 3.00 |
| 2 oz | Methyl salicylate | .25 |
| ¼ lb | Naphtalene | .25 |
| 2 oz | α-Naphtol, pure | .25 |
| 2 oz | β-Naphtol, pure | .25 |
| 2 oz | Oxamide | 2.00 |
| | Total | 141.50 |

# GEOLOGY

## A. Course Content (given only as an example to facilitate the use of the inventories).

*Physical geology.*

(*a*) The earth as a planet; origin and general characteristics of its chief surface features.
(*b*) The physical condition of the earth's crust and interior; evidences of internal activity such as volcanic, seismic and diastrophic phenomena.
(*c*) General characters and inter-relationships of rocks.
(*d*) The work of geological agents; the circulation of rock material, including the processes of denudation, transport, deposition, deformation.

*Mineralogy and petrology.*

(*a*) Elements of crystallography and crystallographic projection and notation.
(*b*) The common rock forming and vein-forming minerals; their physical characters, chemical composition, and modes of origin and occurrence.
(*c*) The simpler optical properties of the common rock-forming minerals and the physical principles on which these properties depend.
(*d*) The general characters and relationships of the chief types of sedimentary, igneous and metomorphic rocks.

*Historical geology.*

The disposition of rocks and its representation on maps; evidences of relative ages of rocks; fossils, their preservation and distribution in rocks of different ages; the geological systems, their broad characters and distribution.

## B. Laboratory Work and Field Work.

Interpretation of simple geological maps in terms of rock-structure and its relation to topography.
Expression of the above interpretation by means of sections.
Graphic methods of finding thickness, dip and strike of beds, of completing outcrops and of tracing the underground extension of strata.
Identification and description of common minerals and typical rocks, with and without the microscope.
Exercises in projection of crystals.
Identification and description of crystal forms of common minerals both on models and on actual crystals.
References of fossils to their broad biological groups and geological periods.
Field work.

## C. Equipment (20 students).

(1) *Demonstration apparatus.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 | Alpine glaciation | 3.50 |
| 1 | Continental glaciation | 3.50 |
| 1 | Youthful stream | 3.50 |
| | Carried forward | 10.50 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 10.50 |
| 1 | Mature stream | 3.50 |
| 1 | Old stream | 3.50 |
| 1 | Underground water | 3.50 |
| 1 | Shoreline of emergence | 3.50 |
| 1 | Cuesta escarpments | 3.50 |
| 1 | Stream capture | 3.50 |
| 1 | Antecedent stream | 3.50 |
| 1 | Anticlinical dome | 3.50 |
| 1 | Hogback | 3.50 |
| 1 | Horsts and grabens | 3.50 |
| 20 | Topographical sheets illustrating different geological processes | 2.00 |
| 1 set | Wall maps of each continent | 60.00 |
| 1 lb | Hydrochloric acid | ·75 |
| 1 lb | Acetic acid | ·75 |
| 1 set | Film strips (selected) | 25.00 |
| 1 | Lantern slide projector | 85.00 |
| 1 | Film slide projector | 18.00 |
| 1 | Projection screen, 7 × 7″ | 20.00 |
| | Total | 257.00 |

(2) *Laboratory collections.*

(*a*) Minerals.

| | | |
|---|---|---|
| 20 | Apatite (crystalline fragments) | 3.00 |
| 20 | Apatite (chlor-apatite, massive) | 3.00 |
| 20 | Augite (showing parting) | 2.00 |
| 20 | Biotite (cleavages) | 2.00 |
| 20 | Calcite (rhombic cleavages) | 2.00 |
| 20 | Calcite (chalk) | 2.00 |
| 20 | Calcite (marble, white) | 2.00 |
| 20 | Calcite (colite) | 2.00 |
| 20 | Calcite (travertine, golden-brown " Onyx marble ") | 2.00 |
| 20 | Chlorite (dark green masses) | 2.00 |
| 20 | Epidote (crystalline, rocky) | 3.00 |
| 20 | Fluorite (antozonite, massive purple) | 2.00 |
| 20 | Fluorite (cleavages, small purple) | 4.00 |
| 20 | Galena (cleavable) | 4.00 |
| 20 | Garnet (almandite-crystalline in micaschist, dodecahedrons) | 2.00 |
| 20 | Garnet (andradite-massive, brown, with Wollastonite) | 2.00 |
| 20 | Garnet (grossularite-masses, greenish gray " South African Jade ") | 4.00 |
| 20 | Garnet (pyrope, in serpentine) | 2.00 |
| 20 | Garnet (rhodolite, masses in micaschist) | 2.00 |
| 20 | Graphite (foliated, pure) | 5.00 |
| 20 | Graphite (crystalline, in schist) | 2.00 |
| 20 | Gypsum (massive, pink or gray) | 2.00 |
| 20 | Gypsum (columnar, pink) | 2.00 |
| 20 | Gypsum (satin spar, choice, long fibrous masses) | 2.00 |
| 20 | Halite (transparent cleavages) | 2.00 |
| 20 | Hematite (micaeous, sparkling mass with magnetite) | 3.00 |
| 20 | Hematite (massive) | 2.00 |
| 20 | Hematite (oolitic) | 2.00 |
| 20 | Hornblende (cleavable) | 3.00 |
| 20 | Kaolinite (compact) | 2.00 |
| | Carried forward | 74.00 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 74.00 |
| 20 | Limonite (amorphous) | 2.00 |
| 20 | Limonite (yellow ochre) | 2.00 |
| 20 | Magnetite (crystalline) | 3.00 |
| 20 | Muscovite (common sheet mica) | 2.00 |
| 20 | Olivine (crystalline) | 2.00 |
| 20 | Orthoclase (sanidine) | 3.00 |
| 20 | Plagioclase (albite, crystalline) | 2.00 |
| 20 | Pyrite (crystalline) | 3.00 |
| 20 | Quartz (translucent) | 2.00 |
| 20 | Quartz (greasy quartz-masses) | 2.00 |
| 20 | Quartz (milky quartz-masses) | 2.00 |
| 20 | Quartz (rose quartz, pink) | 2.00 |
| 20 | Serpentine (massive) | 2.00 |
| 20 | Talc (foliated, sea green) | 2.00 |
| | Total | 105.00 |

(*b*) Rocks.

(*c*) Fossils.

Each region having its own geological history characterized by certain rocks and fossils, it is not possible to give here a list valid in all countries. Therefore, each teacher will have to draw up the list of samples to illustrate his course and to be used in laboratory work, according to the geological structure of his country.

(3) *General apparatus.*

| | | |
|---|---|---|
| 1 | Scale of hardness collection | 1.65 |
| 1 | Luster collection | 13.25 |
| 1 | Fracture collection | 3.30 |
| 1 | Cleavage collection | 1.90 |
| 1 | Tenacity collection | 1.35 |
| 1 | Mineral structures collection | 5.00 |
| 1 set | Crystal models | 30.00 |
| 1,000 | Paste board trays, 2 × 3″ | 25.00 |
| 1 | Jolly balance | 75.00 |
| 1 | Binocular microscope, stereoscopic | 125.00 |
| 1 | Geologist's pick or hammer | 2.75 |
| 1 | Small anvil | 3.00 |
| | Total | 287.20 |

(4) *Individual locker apparatus.*

| | | |
|---|---|---|
| 20 | Streak plates | 2.00 |
| 20 | Blow pipes | 5.00 |
| 10 lb | Charcoal | 7.50 |
| 20 sets | "Hardness" pencils | 130.00 |
| 20 | Small acid dropper bottles | 20.00 |
| 10 doz | Test tubes | 4.00 |
| 10 | Picnometers | 32.50 |
| | Total | 201.00 |

# SOIL SCIENCE

A. Course Content (given only as an example to facilitate the use of the inventories).

(1) Introduction: Man and the soil.
Pedology: Phenomena of pedogenesis. Generic classification of the principal types of soils. Study of the soil from the chemical and physico-chemical point of view. Constituents of the soil: their principal properties, separation, and determination. Soil structure: its physical properties (relations with the atmosphere, water, and solar heat). Study of the absorbant problem and of exchange of phenomena. Qualitative and quantitative laws of these phenomena. Reaction of soils. The soil as a source of mineral elements. The assimilability of these elements; their forms, their evolution in the soil, and their role in plant development. Analytical techniques related to the determination of the assimilability of general elements. Fertilization. The basis of the utilization of mineral elements and fertilizers. Organic matter, its importance and its role; relations between organic matter and fertility and the humus stock. Equilibrium between the alimentary value of the soil medium and the yield and quantity of harvests. The idea of fertility and its recent development.

(2) Supplement on the absorbant problem and exchange phenomena. Complementary study of the mineral elements. Their assimilability. The part played by organic matter in the fertility of soils. Fixation of fertilizers. Importance of trace-elements. Fertilizer equilibria.

B. Practical Work.

*Constituents and physical properties of soils.*

(1) Separation of soil constituents.
Mechanical analysis.
    (a) Properties of clay: Flocculation (influence of the cation bound to the clay, influence of the cation of the flocculant electrolyte, influence of the anion of the flocculant electrolyte);
    (b) Properties of humus: Extraction of humus by ammonium oxalate. Separation of colloidal humic acid (solubilization by bases, precipitation of calcium humate, obtaining of colloidal calcium humate).
(2) Physical properties of soils: Porosity, permeability, water capacity.

*Physico-chemical properties of soils.*

(1) Exchange phenomena:
    (a) Qualitative demonstration of exchange phenomena.
    (b) Determination of exchangeable calcium.
(2) Reaction of soils:
    (a) Determination of hydrolytic acidity.
    (b) Colorimetric pH measurement.
(3) Chemical analysis of soils:
    (a) Determination of assimilable phosphoric acid; Dyer's citric acid method, Schloesing's and Sigmond's methods.
    (b) Determination of exchangeable potassium.
Interpretation of the chemical analysis.

*Biological properties of soils.*

(1) Direct examination of microbial flora of soils by Winogradsky's method.
(2) *Azoctobacter* cultures on silica gel; *Azotobacter* cultures on soil.

### C. FIELD TRIPS.

The exposition of pedology is accompanied by the examination *in situ* of a certain number of typical soil profiles.

### D. EQUIPMENT.

(1) *Demonstration apparatus.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 colln | Photographs | — |
| 1 colln | Wall pictures | 50.00 |
| 1 colln | Slides | 100.00 |
| | Total | 150.00 |

(2) *Individual apparatus for practical work.*

| | | |
|---|---|---|
| 2 | Beakers, 100 cc | .44 |
| 1 | Beaker, 600 cc | .32 |
| 4 | Petri dishes, 6 cm diam | 1.68 |
| 1 | Bunsen burner | .90 |
| 1 | Stand for burner | .75 |
| 1 | Metal gauze | .15 |
| 1.5 m | Rubber tubing | .85 |
| 1 | Mohr burette with stand | 10.70 |
| 4 | Funnels, 6 cm diam | 1.60 |
| 2 | Funnels, 10 cm diam | 1.28 |
| 1 | Funnel stand | 1.60 |
| 1 | Cylinder, graduated, 100 cc | 1.10 |
| 4 | Cylinders, graduated, 500 cc | 9.00 |
| 2 | Erlenmeyer flasks, 150 cc | .50 |
| 2 | Flasks, 1 l | 1.40 |
| 3 | Pipettes, 5, 10 and 20 cc | 1.78 |
| 1 | Pipette stand | .75 |
| 1 | Distilled water reservoir, with tap, 1 l | 1.05 |
| 10 | Test tubes, 1 cm diam | .30 |
| 10 | Test tubes, 2 cm diam | .50 |
| 2 | Test tube stands | 1.40 |
| 4 | Precipitation flasks 250 cc | 2.10 |
| | Total | 40.15 |

## SECOND PART

# BIOLOGICAL SCIENCES

# BOTANY

A. Course Content (given only as an example to facilitate the use of the inventories).

Morphology.
The structure and properties of the cell. The plant body; its structure, development and modifications.

Special morphology. Reproduction and taxonomy.
The general characters of the following groups:
Angiosperms, especially commonly cultivated plants belonging to the families Ranunculaceae, Rosaceae, Leguminosae, Compositae, Labiatae, Scrophulariaceae, Salicaceae, Liliaceae, Iridaceae, Gramineae.
Gymnosperms, especially Pinus and the special features of the Cycas and Taxus.
Pteridophyta, especially Dryopteris and the special features of Selaginella and Lycopodium.
Bryophyta, especially *Pellia* and *Funaria*.
Algae, especially *Chlamydomonas, Pleurococcus, Oedogonium, Spirogyra, Vaucheria* and *Fucus*.
Fungi, especially *Pythium, Mucor,* either *Eurotium* or *Erysiphe, Puccinia, Ustilago, Saccharomyces,* and any common gil bearing fungus.

Bacteria.

Elements of physiology.
The nutrition of plants.
The water relations and aeration of the plant.
Outlines of metabolic changes in the plant, especially respiration and photosynthesis. Growth. Irritability, especially geotropism and phototropism. Elementary knowledge of the soil in relation to the plant.

Elements of evolution and genetics.

Grassland work, cereals and crop plants.
The botanical characteristics of the cereals, legumes, root and fodder plants and chief grasses together with their varieties and strains commonly grown. The systematic position of the Gramineae. Comparison with rushes and sedges. Classification and economic characters and the identification of the commonly occurring grasses and clovers and the parts thereof. Principles underlying the management of grassland. Alteration in grassland plants by grazing and cultural operations. Natural and semi-natural types of grassland. Principles underlying the selection of a seeds mixture. Methods for examining the herbage of meadows and pasture. Classification and comparison of types of wheat, barley and oats. Points of distinction in the diagnosis of new varieties. The general structure of the plant of maize, rice and rye. The effect of external conditions on the cereal crop, laying, tillering, root system. Systematic review of the Natural Orders to which the useful agricultural crop plants belong. Detailed study of the important species and varieties of these plants and their recognition in various stages of growth. Influence of habitat and external conditions on agricultural plants.

Mycology.
An introduction to the study of disease in plants. Methods of plant hygiene and protection, resistance and immunity. The life history of the principal fungus pests of cereals, potatoes, root crops and the hop. Remedial and preventive measures. The mushroom. Yeast and fermentation. Bacteria and their relation to the nutrition of agricultural plants.

Genetics.
Principles of plant breeding, origin of new varieties and development of improved forms.

Seed testing.
Outline of seed testing for farm crops. Seed identification. Object and methods of seed testing. Preliminary inspection of samples; methods of sampling; purity, germination, viability, etc. Adaptations required for special cases. Impurities and their recognition. Points of practical importance as regards legislation.

Weeds and harmful plants.

The nature of the damage caused by weeds. Adaptation of plants or parts of plants for distribution by various agencies. Description of plants or seeds scheduled as poisonous or harmful. Parasitic and semi-parasituc Angiospersm with special reference to dodder and broomrape. Prevention and eradication of weeds; methods correlated with the special life history of plants; effect of cultivations, and chemical methods of control. Conditions of growth of arable contrasted with those of grassland weeds. Vitality of dormant seed. Influence of habitat (change of country, etc.). Weed communities. Weeds as soil indicators. Use of a weed survey. Weed seeds as determinants of place of origin of samples. Classification and identification of common farm weeds.

Foods and feeding stuffs.

Botanical examination of foods and feeding stuffs including the microscopic examination of cakes and meals.

### B. LABORATORY WORK.

The dissection and examination of plants or parts of plants mentioned in the syllabus together with reference to their systematic position.
Simple experiments in practical physiology.
Examination, recognition and description of plants and parts of plants, referred to in the course.
Preparation and mounting of stained sections of plants.
Examination and testing of seed samples.
Use of seed testing apparatus.
Identification of useful and weed seeds.
Examination of diseased plants and identification of parasites.
Preparation of slides. Identification and examination of simple cultures, e.g., yeast, mucor, etc.
Examination of cattle food.
Microscopic diagnosis of constituents of cakes and meals.

### C. FIELD WORK.

Relation of plants to habitat and conditions.
Pasture analysis. Identification of plants and use of flora.

### D. EQUIPMENT (20 students).

(1) *Laboratory apparatus.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 3 | Adaptors, Liebig, bent, 4″ | .25 |
| 2 | Aerators, aquarium, complete with motor diffuser | 31.00 |
| 1 | Autoclave, 13½″ diam | 168.00 |
| 2 | Balances, analytical, 3rd quality, 250 g load | 144.00 |
| 4 | Balances, physical, 250 g load | 36.00 |
| 1 | Balance, Béranger, scalepans, 6″ pans, 2 kg load | 17.00 |
| 6 | Basins, FBL, P, 9 cm diam | 2.00 |
| 12 | Basins, porcelain, 9 cm diam | 6.00 |
| 42 | Beakers, SFL, P, from 100 to 600 cc | 10.00 |
| 4 doz | Beakers, TF, P, from 30 to 800 cc | 17.00 |
| 1 | Bellow, foot, double action, 8″ | 16.00 |
| 1 | Blowpipe, glassworking, 3 jets | 6.00 |
| 6 | Boards, dissecting, raised, wood, 12 × 12″ | 10.00 |
| 6 | Boards, drawing, wood, 23 × 16″ | 9.00 |
| 1 set | Borers, cork, plated brass, 1-12 | 4.00 |
|  | Carried forward | 476.25 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 476.25 |
| 18 | Bosses, retort, iron, medium and large | 5.00 |
| 9 doz | Bottles, NMFS, from 2 to 90 oz | 22.00 |
| 7 doz | Bottles, WMBSC, from 2 to 12 oz | 7.00 |
| 6 | Bottles, water, wash, with IR cork and tubes, 500 cc | 4.00 |
| 6 | Bottles, weighing, ground stopper, 2 × ¾″ | 1.50 |
| 2 | Boxes, microscope slides, 50 slides | 2.00 |
| 2 doz | Boxes, specimen, glass top, 4 × 2 ½″ | 6.00 |
| 1 doz | Brushes, bottle, ½ ft and 1 ft | 1.50 |
| 1 doz | Brushes, test tube | .25 |
| 15 doz | Bungs, solid, from ¾ to 1 ½″ | 16.00 |
| 6 | Burettes, with stopcock, 50 cc | 9.00 |
| 1 doz | Burners, bunsen, 7/16″ | 4.00 |
| 1 | Cabinet, microscope slides, 12 drawers | 30.00 |
| 1 | Cabinet, specimen, bones | 33.00 |
| 1 | Cabinet, specimen, flowers | 33.00 |
| 1 | Cabinet, specimen, fossils | 33.00 |
| 1 | Cabinet, specimen, insects | 33.00 |
| 1 | Camera, photomicrographic, simple eyepiece | 63.00 |
| 1 | Can, oil, conical | .25 |
| 1 | Centrifuge, hand, variable speed, complete, 4 tubes | 21.00 |
| 1 | Centrifuge, electric, 3,000 r.p.m. 4 tubes | 58.00 |
| 18 | Clamps, retort, iron, small and large | 12.00 |
| 1 doz | Clips, screw, hinged, ¾″ | 2.00 |
| 1 doz | Clips, spring, 2″ | 1.00 |
| 4 | Condensers, double surface, rubber joints, 6″ | 7.00 |
| 4 | Condensers, Liebig, rubber joints, 12″ | 3.00 |
| 6 | Cones, bunsen, iron, 6″ | .50 |
| 6 | Connectors, bunsen, india rubber, 18″ | 1.00 |
| 8 gross | Corks, wood bark, from ½ to 1 ¼″ | 16.00 |
| 1 doz | Crucibles and lids | 2.00 |
| 27 | Cylinders, measuring, lipped, from 10 cc to 2 l | 22.00 |
| 3 | Desiccators, ordinary type, soda glass, 6″ | 4.00 |
| 1 | Desiccator, vacuum, soda glass, 8″ | 5.00 |
| 6 pairs | Dishes, culture, soda glass, 9″ diam | 6.00 |
| 12 doz | Dishes, Petri, soda glass, 8 and 10 cm diam | 34.00 |
| 1 | Distillating water apparatus, 2.5 l/h | 53.00 |
| 6 | Dusters, linen, 20 × 20″ | .75 |
| 6 | Dusters, string, 20 × 20″ | .50 |
| 3 | Extractors, Soxhlet, soda glass, 30 cc | 2.50 |
| 6 | Files, triangular, glass cutting, 6″ | 1.00 |
| 4 | Files, rat-tail, 6″ | 1.00 |
| 4 doz | Flasks, conical, NN, P, from 100 to 500 cc | 12.00 |
| 1 doz | Flasks, distilling, P, from 50 to 250 cc | 5.00 |
| 15 | Flasks, FB, P, 500 cc and 1 l | 8.00 |
| 6 | Flasks, filter, P, 500 cc and 1 l | 4.00 |
| 10 | Flasks, graduated, single mark, unstoppered, 100 and 250 cc | 7.00 |
| 6 | Forceps, bent, stainless steel, 10″ | 3.00 |
| 6 | Forceps, bone-cutting, stainless steel, 5 ½″ | 15.00 |
| 6 | Forceps, fine point, straight, stainless steel, 10″ | 2.00 |
| 2 doz | Funnels, filter, glass $60^0$, 4″ | 5.00 |
| 3 | Funnels, Buchner, porcelain, 7 cm | 3.00 |
| 3 | Funnels, Hirsch, porcelain, 7.5 cm | 2.00 |
| 10 | Funnels, separating, globular, 50 and 250 cc | 12.00 |
| 18 | Gauzes, iron wire, asbestos centre, 6 × 6″ | 2.00 |
| 1 | Germinator for seeds, gas or electrically heated, 38 × 20 × 18″ | 120.00 |
| 4 doz | Glass covers, microscope slides, 7/8 and 1″ square | 3.00 |
| 4 doz | Glasses, watch, soda glass, 2 and 3″ | 4.00 |
| | Carried forward | 1,240.00 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 1,240.00 |
| 1 doz | Holders, test tube, wood | 1.00 |
| 1 | Hot plate, electric, 6″ diam | 4.00 |
| 1 | Incubator, biological, 12 × 12 × 14″ | 129.00 |
| 4 sets | Instruments, drawing | 11.00 |
| 6 sets | Instruments, dissecting | 32.00 |
| 1 | Jar, aspirator, for distilled water storage, 6 gal | 7.00 |
| 1 | Jar, bell, flanged, soda glass, 8″ diam | 4.00 |
| 5 doz | Jars, specimen, WMFS, 2 × 2″, 3 × 2″, 4 × 4″ | 23.00 |
| 12 pkgs | Labels, plain, gummed, from 2 × 3/8″ to 3 × 1″ | 1.50 |
| 500 | Labels, gummed, for microscope slides | 1.00 |
| 4 | Lamps, microscope, electric | 13.00 |
| 1 doz | Lamps, spirit, glass | 5.00 |
| 3 | Lenses, dissecting, on stand | 18.00 |
| 1 doz | Lenses, folding, single | 3.00 |
| 1 doz | Lenses, watchmaker's | 5.00 |
| 1 doz | Lifters, section, aluminium, 15 cm | 2.00 |
| 1 | Microprojector, complete with lamp and objective | 63.00 |
| 3 | Microscopes, 2 eyepieces, 16 mm obj lens | 93.00 |
| 3 | Microtomes, hand, 3″ table | 9.00 |
| 2 | Microtomes, with freezing attachment | 300.00 |
| 2 | Mortars and pestles, porcelain, white glazed, 4″ | 1.00 |
| 1 pr | Moulds, for wax, brass, with brass plates | 1.00 |
| 2 doz | Needles, biological, boxwood handle | 1.50 |
| 1 pt | Oil, light, lubricating | .25 |
| 1 | Oven, air, gas, copper, 40 × 25 × 25 cm | 18.00 |
| 1 | Oven, drying, water still, gas or electric, 2 compartments, 8 × 8 × 8″ | 87.00 |
| 1 | Oven, paraffin embedding, electrically heated | 87.00 |
| 50 sheets | Paper, drawing, 23 × 16″ | 2.50 |
| 12 boxes | Paper, filter, Whatman No. 1, from 7 to 11 cm | 3.00 |
| 6 books | Paper, test, litmus, blue | .50 |
| 6 books | Paper, test, litmus, red | .50 |
| 6 books | Paper, test, starch-iodide | .50 |
| 6 | Pencils, " Chinagraph " | .50 |
| 1 | pH meter | 195.00 |
| 6 | Pieces, T, soda glass, ¼″ diam | .50 |
| 1 gross | Pins, entomological | .50 |
| 1 | Pipette, graduated, from 1 to 10 cc | 6.00 |
| 16 | Pipettes, single mark, from 10 to 50 cc | 8.00 |
| 4 doz | Plates, photo, process, rapid | 3.00 |
| 1 | Presser, cork, iron, rotary | 2.00 |
| 4 | Pumps, filter, soda glass | 3.00 |
| 4 | Razors, hollow ground | 3.00 |
| 8 | Rings, retort, iron, 2 and 3″ | 2.50 |
| 9 lb | Rod, soda glass, from 3 to 7 mm | 4.00 |
| 8 | Scalpels, 1 ½″ blade | 4.00 |
| 8 pr | Scissors, stainless steel, 5″ | 6.00 |
| 11 | Sharpeners, cork borer | .50 |
| 1 gross | Slides, microscope, plain, 3 × 1″ | 1.00 |
| 4 doz | Slides, microscope, cavity, 3 × 1″ | 2.00 |
| 1 doz | Spatulas, bone, 4″ | .75 |
| 8 | Spatulas, nickel, 9 and 11 cm | 2.00 |
| 2 | Spoons, deflagrating, brass | .50 |
| 4 | Stands, burette, wood, double clip | 6.00 |
| 4 | Stands, filter, wood, double clip | 4.00 |
| 3 doz | Stands, retort, iron, from 18 to 24″ rod | 27.00 |
| 1 | Stand, staining, fitted, complete, 14 × 3″ | 3.00 |
| 6 | Stands, test tube, wood, 12 holes | 4.00 |
| 12 | Stands, tripod, iron, triangular, 5 × 5 × 5″ | 3.00 |
| | Carried forward | 2,459.00 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 2,459.00 |
| 1 | Stand, water tube, with boss head and clamp | 6.00 |
| 1 | Sterilizer, hot air, gas or electrically heated, 15 × 15 × 15″ | 144.00 |
| 1 | Stone, carborundum, 8 × 2″ | 1.50 |
| 1 | Stone, oil, india, 6 × 1 ½″ | 1.00 |
| 16 | Stopcocks, two-way, straight, soda glass, 2 to 7 mm | 18.00 |
| 6 | Stopcoocks, two-way, T, soda glass, 2 to 4 mm | 9.00 |
| 18 | Thermometers, mercury, solid stem, 0-110° C, 0-240° C | 12.00 |
| 12 | Thermometers, mercury, solid stem, 0-260° F | 11.00 |
| 2 | Tanks, aquarium, glass, 16 × 10 × 9 ½″ | 15.00 |
| 1 box | Thimbles, Soxhlet, 19 × 90 mm | 4.00 |
| 1 doz | Tiles, porcelain, white glazed, 6 × 6″ | 5.00 |
| 6 pr | Tongs, crucible, brass, bowed, 8″ | 2.00 |
| 1 set | Tools, glass blowing, 2″ | 6.00 |
| 6 | Triangles, crucible, pipeclay, 2″ | 2.00 |
| 3 | Troughs, staining, 10 slides | 3.00 |
| 4 | Tubes, drying, calcium chloride, 4″ | .50 |
| 12 doz | Tubes, specimen, FB, corked, from 2 × ½″ to 4 × 1″ | 4.50 |
| 1 gross | Test tubes, Monax, 6 × 1″ | 4.00 |
| 2 gross | Test tubes, soda glass, 5 × $^3/_8$″, 6 × ¾″ | 6.00 |
| 3 | Tubes, U, soda glass, 4 × ½″ | .50 |
| 12 yd | Tubing, india rubber, pressure, seamless, $^3/_{16}$ × ½″, $^5/_{16}$ × ½″ | 4.00 |
| 16 lb | Tubing, soda glass, from 2 to 8 mm | 6.00 |
| 3 sets | Weights, analytical, 1st year quality, 100-0.001 g | 29.00 |
| 2 sets | Weights, physical, brass, 200-0.001 g | 9.00 |
| 1 set | Weights, physical, brass, 1 kg-1 g | 6.00 |
| 1 lb | Wire, copper, DCC, 18, 20 and 22 SWG | 4.00 |
| | Total | 2,772.00 |

(2) *Chemicals (annual consumption).*

| | | |
|---|---|---|
| 3 lb | Acetic acid, glacial | 1.00 |
| 1 lb | Acid, chromic, cryst | .50 |
| 3 winch | Acid, hydrochloric, conc, pure | 4.00 |
| 1 winch | Acid, nitric, conc, pure | 1.00 |
| 2 winch | Acid, sulphuric, conc, pure | 2.00 |
| 2 lb | Alcohol, amyl | 1.00 |
| 1 gal | Alcohol, ethyl, absolute | 1.00 |
| 4 gal | Alcohol, ethyl, methylated, spirit | 2.50 |
| 1 gal | Alcohol, ethyl, rectified spirit, 64% | .50 |
| 1 gal | Alcohol, methyl, methanol | 1.00 |
| 1 lb | Alum, iron, cryst., pure | .50 |
| 1 lb | Aluminium chloride, cryst., pure | 1.00 |
| 10 lb | Ammonium sulphate, cryst., pure | 2.50 |
| 1 lb | Barium hydroxide, cryst., pure | .50 |
| 2 lb | Benzene, crystallizable | .25 |
| 2 lb | Carbon tetrachloride, pure | .50 |
| 2 lb | Chloroform | 2.00 |
| ½ pt | Developer, photographic | .25 |
| 4 winch | Formaldehyde, soln, 40% | 2.00 |
| 1 lb | Gelatine, sheet, best white | 2.00 |
| 2 lb | Glucose, AR | 2.00 |
| 2 lb | Glycerine, pure | .50 |
| ¼ lb | Iodine, resublimed | .50 |
| 1 lb | Lactose, AR | 1.00 |
| ¼ lb | Laevulose, purest | 2.00 |
| ¼ lb | Maltose, purest | 1.50 |
| 1 lb | Magnesium chloride, cryst, pure | .25 |
| | Carried forward | 33.75 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 33·75 |
| 1 winch | Paraffin, liquid, AR | 2.00 |
| 7 lb | Paraffin wax, white | 2.00 |
| 1 lb | Potassium iodide, AR | 4.00 |
| 10 lb | Sodium carbonate, cryst, pure | 1.00 |
| 3 lb | Sodium chlorate, cryst, pure | .25 |
| 4 lb | Sodium hydroxide, pellets, pure | .25 |
| 2 lb | Toluene, pure | .25 |
| 2 lb | Vaseline, white | 2.00 |
| 3 lb | Xylène, pure | 1.00 |
| | Total | 46.50 |

(3) *Stains.*

| | | |
|---|---|---|
| 5 g | Aniline, blue, micro stain, water soln | .25 |
| 5 g | Auramine, micro stain | .25 |
| 5 g | Biebrich scarlet, micro stain | .25 |
| 5 g | Bismark brown | .25 |
| 5 g | Carmine | .25 |
| 5 g | Congo red | .25 |
| 5 g | Crystal violet | .25 |
| 5 g | Eosine, alcoholic soln | .50 |
| 5 g | Erythrosine | .50 |
| 5 g | Fuschine, basic | .25 |
| 5 g | Haematoxylin, Ehrlich | .25 |
| 5 g | Light green | .25 |
| 5 g | Malachite green | .25 |
| 5 g | Methyl blue | .25 |
| 5 g | Methylene blue | .25 |
| 5 g | Methyl violet | .25 |
| 5 g | Nigrosine | .25 |
| 5 g | Phenol red | .25 |
| 5 g | Safranine | .25 |
| 5 g | Trypan blue | .25 |
| 5 g | Victoria blue | .25 |
| | Total | 5·75 |

(4) *Oils and mounting media.*

| | | |
|---|---|---|
| 200 g | Asphalt varnish | 1.00 |
| 200 g | Canada balsam, in xylol | 4.00 |
| 100 g | Cement, cover glass | .50 |
| 100 g | Glycerine jelly | .75 |
| 100 g | Gold size | .50 |
| 100 g | Microscopic cement | .75 |
| 100 g | Oil, cajaput | 2.00 |
| 200 g | Oil, cedarwood | .50 |
| 100 g | Oil, cloves | 1.00 |
| | Total | 11.00 |

# ZOOLOGY

A. Course Content (given only as an example to facilitate the use of the inventories).

A study of the structure and of the elementary physiology of the rabbit.

The structure, mode of life and life-history of the following animals: Amoeba, Euglena, Paramecium, Hydra, Obelia, Earthworm, Crayfish, Amphioxus, Dogfish, Frog and Rabbit, in illustration of the general characteristics of animal organization.

Elementary physiology: metabolism; nutrition (digestion, assimilation and food storage); respiration, excretion, movement, response to stimuli and reflex action; growth and reproduction. The differences between plants and animals.

Modification of structure, habit and life history associated with parasitism (including mode of transmission from host to host) as exemplified by Monocystis, Trypanosoma, the malarial parasite, the liver fluke and the tape worm. Symbiosis.

The principles of classification and nomenclature. A discussion of the systematic position of the animals mentioned above and of their place in their respective phyla, and of these phyla in the animal kingdom.

The structure of a cell. Cell division. The multi-cellular organism illustrating morphological differentiation and the division of labour. The essential characteristics of the following: epithelial tissue, connective and supporting tissue (including the process of ossification); blood and lymph; muscular tissue; nervous tissue.

Sexual and asexual reproduction. The chief types of ova. Gameto-genesis. Fertilization and cleavage. The germ layers and their formation in Amphioxus, Frog and Chick. The development and metamorphosis of the Frog. The development of the Chick up to the end of the third day of incubation. The development and functions of the foetal membranes of the Chick and Mammal.

Variation and heredity, including a simple treatment of the facts of genetics and nuclear cytology.

The evidence bearing on the occurrence of organic evolution. The theories of Lamarck and Darwin as to the method of evolution.

The anatomy and physiology of the Horse, Ruminant and Pig.

The microscopic structure and function of the tissues of the body.

The skeleton of the Horse and the chief differences in the Ruminant and Pig.

The structure and function of the digestive, circulatory, respiratory, urinary, nervous and reproductive systems of the farm animals.

The mamary glands and the endocrine glands.

General principles.

The general systematics and biology of animal groups important to agriculture, with detailed life histories and control of important pests of crops and parasites of stock.

Entomology.

Anatomy and physiology and development of Insects. Classification and biology of important insect orders.

Plant pests.

Identification, life history and control of important plant pests; Insects, Arachnids, Myriapods, Molluscs and plant parasitic Nematodes.

Parasitology.

Recognition and bionomics of external parasites of domestic animals; Insects, Mites and Ticks. Structure and classification of Trematodes, Cestodes and Nematodes. Life histories and bionomics of important species of Helminth parasites. An outline of the more important protozoan parasites of domestic animals.

Birds and Mammals.

Recognition and agricultural status of common species.

Principles of control.

Principles of animal ecology. Relationship of pests to their environment; cultural and biological methods of control. The nature and use of insecticides. Legislative measures.

## B. LABORATORY WORK.

The dissection, or microscopical examination of whole mounts and sections of the animals mentioned above (omit malarial parasite and Trypanosoma).
The examination of the skeleton of the vertebrate types mentioned above together with the skull of the Dog.
The examination of prepared sections of the following vertebrate organs: skin, stomach, intestine, liver, kidney, ovary testis and spinal cord.
The preparation of stained permanent mounts of suitable whole animals, parts of animals and tissues.
A study of the external changes during the development of the Frog from fertilization to the end of metamorphosis.
The examination of whole mounts of and representative sections through:
(*a*) The early stages of Frog development to the time of the first appearance of the external gills;
(*b*) stages illustrating the development of the Chick during the first, second and third days.
Dissection, microscopical examination and description of specimens of parts of the following animals: Snail, Wasp, Eelworm, Ascaris.
Examination of external features of Millipedes and Centipedes.
Determination of zoological position of animals belonging to groups covered in the course.

## C. FIELD WORK.

Recognition in the field of the more important animals of economic importance.

## D. EQUIPMENT (20 students).

(1) *Laboratory equipment.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Boards, setting, 35 cm long, flat or oval as required: | |
| 40 | 12 mm thick | 108.00 |
| 40 | 18 mm thick | 120.00 |
| 40 | 25 mm thick | 144.00 |
| 40 | 35 mm thick | 180.00 |
| 40 | 60 mm thick | 228.00 |
| 6 | Bottles, balsam, ground on cap | 3.00 |
| 160 | Bottles, oval, killing and collecting, glass, with rounded top cork, 8.5 cm high × 3.5 cm diam | 56.00 |
| 100 | Boxes, insect, pine frame, plywood top and bottom 16 × 11″ | 255.00 |
| 240 | Bristol boards, 3-ply, 35 × 25 cm | 20.00 |
| | Bristol boards, discs, in boxes of 500: | |
| 3 boxes | 12 mm diam | 2.00 |
| 3 boxes | 15 mm diam | 3.00 |
| 3 boxes | 18 mm diam | 3.00 |
| 3 boxes | 21 mm diam | 4.00 |
| 40 | Brushes, camel hair, small | 1.00 |
| 40 | Brushes, camel hair, medium | 1.00 |
| 10 | Cages, larva, three sides perforated zinc, one side glass, top removable with zinc tray, 13.5 × 13.5 × 22.5 cm | 29.00 |
| 1 | Camera, general utility, with f/6 lens, moving lens panel, swing back, 3 double dark slides | 168.00 |
| 10 doz | Cork sheets, compressed, 45 × 30 × 0.5 cm | 34.00 |
| 6 oz | Cover glass, rectangular, packed in ½ oz boxes, 2 × 7/8 × 0.005″ | 9.00 |
| 6 oz | Cover glass, round, packed in ½ oz boxes, ¾″ diam × 0.005″ | 12.00 |
| | Carried forward | 1,380.00 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 1,380.00 |
| 6 oz | Cover glass, square, packed in ½ oz boxes, ¾ × ¾ × 0.005″ | 4.00 |
| 1 | Epidiascope, with 16″ f/3.5 anastigmat lens, twincooling fans, glass plate, slide carrier, observation window, twin and single lamp switches, two 6″ condensers, two 4 ½″ condensers, supplementary lens for diascopic projection, with 2-500 watt mirror backed lamps | 288.00 |
| 15 | Forceps, straight, fine point, 12.5 cm | 8.00 |
| 15 | Forceps, straight, medium point, 12.5 cm | 8.00 |
| 15 | Forceps, straight, blunt point, 12.5 cm | 8.00 |
| 1 | Guillotine, table pattern, 9″ cut | 4.00 |
| 10,000 | Labels, for microscope slides, ⁷/₈ × ⁷/₈″ | 8.00 |
| 8 | Lenses, pocket, 3 lenses in vulcanite case, 1 ¼″ diam. | 12.00 |
| 10 | Magnifiers, 10×, aplanatic, in folding nickel plated case, 13 mm aperture | 46.00 |
| 1 | Microscope, binocular, comprising: | |
| | Microscope stand, high power binocular body, triple nose piece, 3 objectives, 15×, 60×, 20×, 3 eyepieces, 6×, 8×, 10×, oil immersion NA 1.28, substage condenser, mechanical stage, in case | 480.00 |
| 2 | Microscopes, binocular, with inclined eyepiece tubes, obj 9.4×, 5.65×; ocul. 5×, 10×; with hand rests, in case | 360.00 |
| 40 | Needles, blunt, in ebony handles | 18.00 |
| 80 boxes | Needles, setting, with glass heads | 16.00 |
| 10 doz | Needles, straight, in rosewood handles | 9.00 |
| 5 | Nets, butterfly, folding wire frame, adjustable to fit any size stick, 35 cm diam | 15.00 |
| 35 boxes | Pins, entomological, continental, black, 1,000 of each size No. 000, 00, 0, 1, 2, 3, 4 | 60.00 |
| 5,000 | Pins, micro, stainless steel, 12.5 × 0.05 mm | 15.00 |
| 100 g | Polyporous, white, 2 mm section | 1.00 |
| 1 | Projector, micro, simple | 63.00 |
| | Punches for cutting Bristol board: | |
| 1 | 12 mm diam | .50 |
| 1 | 15 mm diam | .50 |
| 1 | 18 mm diam | 1.00 |
| 1 | 21 mm diam | 1.00 |
| 5 doz | Scalpels, best quality, in ebony handles, assorted shapes as required | 29.00 |
| | Scissors, best quality: | |
| 15 pr | dissecting, fine point, straight, 5″ | 12.00 |
| 15 pr | dissecting, fine point, curved up, 5″ | 13.00 |
| 15 pr | dissecting, fine point, straight, 5″ | 13.00 |
| 15 pr | ordinary laboratory pattern, straight, 6″ | 9.00 |
| 10 gross | Slide, microscopic, with ground and polished edges, 3 × 1″ | 15.00 |
| 15 | Stages for examining pinned insects, to suit long or short pins as required | 125.00 |
| 5 | Sticks, collecting, plain cane, in two sections, screwing together, for use with butterfly net, 75 cm each section | 3.00 |
| 20 | Tiles, glazed, half white, half black, with cork cemented on reverse side, 15 × 15 cm | 13.00 |
| 10 doz | Watch glasses, FB, 60 mm diam | 5.00 |
| 1 | Collection of insects, of different orders | 600.00 |
| | Total | 3,643.00 |

(2) *Chemicals.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 14 lb | Calcium chloride, pure anhydrous | 4.00 |
| 3 lb | Camphor | 4.50 |
| | Carried forward | 8.50 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 8.50 |
| 3 lb | Canada balsam | 7.00 |
| 4 lb | Chloral hydrate | 7.00 |
| 6 lb | Chloroform | 6.00 |
| ½ lb | Euparal | 12.00 |
| ½ l | Euparal essence | 7.00 |
| 10 lb | Formaldehyde 40% | 6.00 |
| 20 lb | Glycerine, pure | 6.00 |
| 3 lb | Gum arabic | 2.00 |
| 2 lb | Gum tragacanth, powder | 12.00 |
| 60 lb | Xylene, pure | 15.00 |
| | Total | 88.50 |

# BACTERIOLOGY

A. Course Content (given only as an example to facilitate the use of the inventories).

*An introduction to general bacteriology.*

Bacterial morphology and physiology. Bacteriological variation. Bacteriological technique, including the preparation and use of media, staining methods, and the isolation of pure cultures. The morphological and cultural characters of bacteria. Bacteriological classification. Bacteriology of water and sewage. Immunity and disease.

*The bacteriology of milk.*

Numbers and types of bacteria in milk. Abnormalities in milks. Milk processing and its effect on the microflora. Isolation of starter organisms. The bacteriology of dairy products. Designated milks. Dye-reduction tests. Bacteriophage. Detergents and disinfectants. Bacteriological aspects of common diseases of farm animals. Milk-borne diseases. Mastitis.

*The bacteriology of soil.*

The soil population and variability of soil counts. Physiological groups of bacteria and their influence on the composition of the soil. Soil conditions and their effects on the microflora. Partial sterilization. The bacteriology of manure and silage.

B. Laboratory Work.

Preparation of nutrient media, including broth, sugar, broth and agar.

Bacterial morphology including examination in the living state, the simple stain and the spore stain.

Demonstration of capsules; the acid-fast stain; the gram stain.

The study of representative species of bacteria with regard to colonial morphology, microscopic morphology, stain reactions, the fermentation of dextrose, lactose and sucrose.

The hydrolysis of starch.

Nitrate reduction.

Hydrogen sulfide formation, indol formation and reaction in litmus milk culture.

Bacterial species, including *Staphylococcus aureus*, *Staphylococcus albus*, *Staphylococcus citreus*, *Sarcine lutea*, *Bacterium coli*, *Bacterium aerogenes*, *Salmonella suipestifer*, *Proteus vulgaris*, *Bacterium prodigiosum*, *Pseudomonas pyocyaneus*, *Bacillus subtilis*, and *Bacillus megatherium*.

Morphology of higher fungi, including one species of yeast and three species of molds.

The effect of ultra violet light on bacteria.

The differentiation of *Bacterium coli* and *Bacterium aerogenes* on the basis of the production of indol, the methyl red test, the Voges-Proskauer and citrate test.

The bacteric-static effect of dyes using methyl violet and mercurochrome.

The effect of increased osmotic pressure on the bacterial morphology.

The pathogenicity of bacteria, in which pneumococcus injected in the mouse and *Anthrax bacillus* in the guinea pig are demonstrated.

The bacteriological examination of water (A.P.H.A. Standard method).

Types of bacteria in air, soil, throat and skin.

Bacterial examination of milk, including total bacterial count, differential count, the physiological types of bacteria; the methylene blue reduction tests; the direct microscopic count of bacteria (the Breed method).

The agglutination reaction, including micro-agglutination and H- and O-agglutination.

C. EQUIPMENT (20 students).

(1) *Laboratory equipment.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 | Autoclave, vertical, 13″ diam | 176.00 |
| 2 | Automatic filling apparatus, 10 cc | 35.00 |
| 1 | Balance, analytical, 2nd quality, 200 g load | 85.00 |
| 1 | Balance, Beranger, 6″ scalepans, 1 kg load | 20.00 |
| 1 | Balance, physical, in case, 200 g load | 43.00 |
| 12 | Basins, FBL, P, 7 and 9 cm | 4.00 |
| 21 | Basins, porcelain, L, from 7 to 18 cm | 18.00 |
| 6 | Baskets, wire for test tubes, 6 × 6 × 6″ | 8.00 |
| 1 | Bath, water, agglutination, electrical or gas heating, 10 racks | 47.00 |
| 7 doz | Beakers, SFL, P, from 30 cc to 2 l | 25.00 |
| 30 | Beakers, TF, P, from 100 cc to 1 l | 9.00 |
| 1 | Bellows, foot, double action, 12″ | 16.00 |
| 1 | Blow pipe, glassworking, air-gas | 11.00 |
| 1 set | Borers, cork, plated, set of 12 | 4.00 |
| 18 | Bosses, retort, iron | 4.00 |
| 16 | Bottles, aspirator, from 1 to 10 l | 26.00 |
| 1 gross | Bottles, dropping, clear glass, 60 cc | 33.00 |
| 9 doz | Bottles, NMFS, from 1 to 40 oz | 18.00 |
| 2 doz | Bottles, NMFS, Winchester, 80 oz | 10.00 |
| ½ gross | Bottles, vaccine, 60 cc | 3.00 |
| 4 doz | Bottles, WMFS, from 2 to 16 oz | 12.00 |
| 8 | Brushes, bottle, ½ and 1 pint | 1.00 |
| 2 doz | Brushes, test tube | .50 |
| 2 | Buckets, enamelled iron, 8 l | 3.00 |
| 2 doz | Burettes, with stopcock, 25 and 50 cc | 36.00 |
| 1 | Burner, batswing, 8″ | 1.00 |
| 2 doz | Burners, bunsen | 9.00 |
| 2 doz | Burners, bunsen, with bypass | 11.00 |
| 1 | Burner, ring, iron, 5″ | 1.00 |
| 88 | Bungs, indiarubber, solid, from ½ to 1 ¼″ | 5.00 |
|  | Carried forward | 674.50 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 674.50 |
| 52 | Bungs, indiarubber, 1 hole, from 5/8 to 1 ¼″ | 7.00 |
| 48 | Bungs, indiarubber, 2 holes, from 5/8 to 1 ¼″ | 7.00 |
| 2 sets | Candles, filter, Berkefeld, 5 × 1″ | 2.00 |
| 1 | Centrifuge, electric, 3,000 rpm, with spare heads for 20 and 50 ml tubes, 4 tubes | 351.00 |
| 2 doz | Clamps, retort, iron | 10.00 |
| 1 doz | Clips, Hofman, screw, medium | 2.00 |
| 1 | Comparator, Lovibond | 32.00 |
| 1 | Colorimeter | 162.00 |
| 4 | Colony counters, Buck | 428.00 |
| 16 | Condensers, Liebig, rubber connections, 12 and 15″ | 6.00 |
| 46 doz | Corks, wood bark, from ¼ to 2″ | 11.00 |
| 1 | Cutter, glass, steel with wooden handle | 50.00 |
| 58 | Cylinders, measuring, L, from 10 cc to 2 l | 39.00 |
| 1 | Diamond, glass criting | 2.00 |
| 8 pr | Dishes, culture, soda glass, in pairs, 9″ diam | 12.00 |
| 2 gross | Dishes, Petri, soda glass, 4″ diam | 18.00 |
| 3 doz | Dusters, linen, 20 × 20″ | 4.00 |
| 1 doz | Dusters, string, 20 × 20″ | 1.00 |
| 1 | Extractor, Soxhlet, 30 cc | 1.00 |
| 1 | Filter, Seitz, silver-plated brass, from 6 mm pads | 23.00 |
| 88 | Flasks, conical, NN, P, from 50 cc to 1 l | 20.00 |
| 82 | Flasks, conical, WN, P, from 100 cc to 2 l | 24.00 |
| 8 | Flasks, distilling, P, 100 and 250 cc | 4.00 |
| 43 | Flasks, FB, P, from 500 cc to 4 l | 20.00 |
| 28 | Flasks, filter, soda glass, from 100 cc to 1 l | 15.00 |
| 2 | Flasks, filter, P, 2 l | 4.00 |
| 22 | Flasks, graduated, stoppered, from 50 cc to 1 l | 20.00 |
| 10 | Funnels, Buchner, porcelain, 5 and 18 cm | 14.00 |
| 8 doz | Glasses, watch, 2 and 2 ½″ | 4.00 |
| 1 | Haemocytometer | 13.00 |
| 8 | Haemocytometers, counting chambers, Thoma, with cover slips, 0.1 mm deep | 56.00 |
| 1 | Incubator, 30° C, gas or electric heating, 15 × 15 × 18″ | 112.00 |
| 1 | Incubator, 60° C, gas or electric heating, 15 × 15 × 18″ | 118.00 |
| 1 | Jar, anaerobic, with carbon lamp for resistance, 9 × 4 ¾″ | 36.00 |
| 1 | Jar, aspirator type, stoneware, for distilled water storage, 10 gal | 15.00 |
| 12 pkts | Labels, plain, gummed, 2 × ¾″ to 3 × 1″ | 1.00 |
| 5,000 | Labels, plain, gummed, for microscope slides ½ × ½″ | 4.00 |
| 1 | Lamp, arc, mercury, quartz with controls | 132.00 |
| 18 | Micrometers, eyepiece, for microscope, 10 × 0.1 mm | 72.00 |
| 4 | Micrometer stages, ruled 0.0001 mm | 15.00 |
| 1 | Microprojector, prism type, complete with transformer | 63.00 |
| 1 | Microscope, research, obj 15×, 60×, 120×; ocul 6×, 8×, 10×; oil immersion, substage condenser, iris, diaphragm, mechanical stage, in case | 180.00 |
| 5 | Microscopes, student's model, 3 objectives, 1, 2/3, 1/16″, 2 eyepieces 5× and 10×, substage condenser, in case | 300.00 |
| 4 | Mortars, agate, 2″ | 14.00 |
| 4 | Mortars, porcelain, glazed white, 4″ | 2.00 |
| 4 | Mortars, Wedgwood, 6″ | 7.00 |
| 4 doz | Needles, microscope, straight | 5.00 |
| 48 | Paper filters, Whatman No. 1, in boxes, from 7 to 18 cm | 16.00 |
| 1 gross | Paper filters, Whatman No. 1, in sheets, 22 × 18″ | 6.00 |
| 1 | pH meter, potentiometer type | 195.00 |
| 4 doz | Pipettes, graduated, 1 cc | 18.00 |
| 4 doz | Pipettes, graduated, 10 cc | 23.00 |
| 13 doz | Pipettes, graduated, single mark, from 1 to 100 cc | 47.00 |
| | Carried forward | 3,417.50 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 3,417.50 |
| 1 | Presser, cork, rotary | 2.00 |
| 1 doz | Pots, glass, for used microscope slides, 1 lb | 1.00 |
| 8 | Pumps, filter, soda glass | 6.00 |
| 4 | Racks, staining, with brass ends and levelling feet, to fit any sink | 7.00 |
| 1 | Refrigerator, gas or electric or oil | 180.00 |
| 6 lb | Rod, soda glass, from 3 to 5 mm diam | 2.00 |
| 24 | Scalpels, with ebony handle, assorted shapes | 36.00 |
| | Scissors, surgical, straight, stainless: | |
| 8 pr | blunt point, 6″ | 16.00 |
| 8 prs | sharp point, 6″ | 16.00 |
| 1 | Sharpener, cork borer | 1.00 |
| 25 gross | Slides, microscope, plain, 3 × 1″ | 35.00 |
| 72 | Slides, microscope, 1 cavity, 3 × 1″ | 4.00 |
| 36 | Spatulas, nickel, 9 and 11 cm | 7.00 |
| 1 doz | Stands, burette, wood, single clamp | 13.00 |
| 1 doz | Stands, filter, wood | 18.00 |
| 16 | Stands, retort, iron, 18 and 20″ | 8.00 |
| 4 doz | Stands, test tube, metal, 12 holes | 72.00 |
| 2 doz | Stands, test tubes, wood, 12 holes | 26.00 |
| 2 doz | Stands, tripod, iron, 5″ diam | 8.00 |
| 1 | Sterilizer, gas, electric or steam heated, 50 × 30 × 30″ | 64.00 |
| 1 | Sterilizer, hot air or electric heating, 15 × 15 × 15″ | 148.00 |
| 4 | Stopcocks, 2-way, soda glass | 3.00 |
| 4 | T pieces, soda glass, 5 mm bore | .25 |
| 2 tins | Tap grease, rubber, medium | 1.00 |
| 72 | Teats, rubber, red, medium | 5.00 |
| 28 | Thermometers, mercury filled, engraved stem, 0-100° C, 0-210° C, 0-360° C | 25.00 |
| 2 doz | Tins, square, without lid, 6 × 6 × 6″ | 9.00 |
| 1 | Still, water, electric or gas heating | 76.00 |
| 4 | Tiles, porcelain, glazed white, 6 × 6″ | 2.00 |
| 1 doz | Tubes, centrifuge, graduated, 15 cc | 4.00 |
| 20 | Tubes, centrifuge, plain, 25 and 50 cc | 5.00 |
| 1 gross | Tubes, fermentation, Durham, 1 × ¼″ | 1.00 |
| 2 gross | Tubes, P, agglutination, 9 × 1 cm | 10.00 |
| 10 gross | Tubes, test, P, 6 × ¾″ and 6 × 1″ | 60.00 |
| 8 doz | Tubes, test, with mark at 10 ml, 6 × $^{5}/_{8}$″ | 6.00 |
| 72 | Tubes, Wassermann, P, 3 × $^{3}/_{8}$″ | 1.00 |
| 75 yd | Tubing, indiarubber, seamless, from $^{3}/_{16}$ to $^{5}/_{16}$″ | 15.00 |
| 20 yd | Tubing, indiarubber, seamless, pressure, small, medium and large | 10.00 |
| 5 lb | Tubing, soda glass, 5 mm bore | 2.00 |
| 3 lb | Tubing, soda glass, 9 mm bore | 1.00 |
| 4 sets | Weights, analytical, brass plated, in box, 100 g to 1 mg | 45.00 |
| 1 set | Weights, analytical, brass plated, in box, 1 kg to 1 g | 6.00 |
| 1 lb | Wire, copper, 16 SWG | 1.00 |
| ¼ lb | Wire, nichrome, for wire loops, 16 SWG | 2.00 |
| 5 doz | Wire, loop holder, bone handle, adjustable head | 24.00 |
| | Total | 4,401.75 |

(2) *Chemicals.*

(a) Inorganic.

| | | |
|---|---|---|
| 1 lb | Acid, boric, powdered, AR | .50 |
| 2 lb | Acid, chromic, cryst, pure | 2.00 |
| 3 winch | Acid, hydrochloric, conc, cmml | 1.50 |
| 3 winch | Acid, hydrochloric, conc, AR | 3.00 |
| 2 winch | Acid, nitric, conc, comml | 2.00 |
| | Carried forward | 9.00 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 9.00 |
| 3 winch | Acid, nitric, conc, pure | 3.00 |
| 2 lb | Acid, oxalic, cryst, pure | .50 |
| 1 lb | Acid, phosphotungstic, pure | 5.00 |
| 3 winch | Acid, sulphuric, conc, comml | 2.00 |
| 4 winch | Acid, sulphuric, conc. pure | 5.00 |
| 3 lb | Alum, ammonium, cryst, pure | 1.00 |
| 3 lb | Alum, iron, cryst, pure | 1.00 |
| 1 lb | Alum, potassium, cryst, pure | .25 |
| 3 winch | Ammonia, soln, 0.880, pure | 4.00 |
| 3 lb | Ammonium, carbonate, lump, pure | 1.00 |
| 7 lb | Ammonium, chloride, cryst, pure | 2.00 |
| 5 lb | Ammonium, dihydrogen phosphate, crystalline, pure | 4.00 |
| 5 lb | Ammonium sulphate, recrystallized, pure | 1.00 |
| 1 kg | Blood diluting fluid, Thoma's | 2.00 |
| 3 lb | Borax, powdered, BP | .50 |
| 4 lb | Calcium chloride, anhydrous, comml | 1.00 |
| 4 lb | Calcium chloride, anhydrous, pure | 1.00 |
| 2 lb | Calcium oxide, powdered, pure | .50 |
| 4 lb | Charcoal, animal, powdered | 1.00 |
| 1 lb | Copper, sulphate, cryst, pure, AR | .50 |
| 1 lb | Ferric chloride, pure | .25 |
| 2 lb | Ferrous sulphate, cryst, pure | .25 |
| 2 winch | Hydrogen peroxide soln, 100 vol | 2.00 |
| 1 lb | Iodine, resublimed, pure | 3.00 |
| 1 lb | Lead acetate, cryst, pure | .50 |
| 1 lb | Magnesium carbonate, powdered, light, pure | .50 |
| 1 lb | Magnesium sulphate, cryst, pure | .25 |
| 7 lb | Mercury metal | 11.00 |
| 5 ft | Platinum wire, 0.012 diam | 6.00 |
| 3 lb | Potassium acetate, anhydrous, pure | 1.00 |
| 1 lb | Potassium bromide, cryst, pure | 1.00 |
| 4 lb | Potassium carbonate, anhydrous, pure | 2.00 |
| 2 lb | Potassium cyanide, 90-95% | 6.00 |
| 2 lb | Potassium ferricyanide, cryst, pure | 2.00 |
| 2 lb | Potassium dihydrogen phosphate, pure | 2.00 |
| 2 lb | Potassium dichromate, cryst, pure | .50 |
| 2 lb | Potassium (di), hydrogen phosphate, pure | 2.00 |
| 1 lb | Potassium hydroxide, pellets, pure | 1.00 |
| 2 lb | Potassium hypochlorite (Eau de Javel) | 1.00 |
| 1 lb | Potassium iodide, cryst, pure | 2.00 |
| 2 lb | Potassium nitrate, cryst, pure | .50 |
| 2 lb | Potassium permanganate, cryst, BP | 1.00 |
| ½ lb | Potassium tellurite | 2.00 |
| 2 lb | Potassium thiocyanate, cryst, pure | 5.00 |
| ½ lb | Silver nitrate, cryst, AR | 6.00 |
| 1 lb | Sodium acetate, cryst, pure | .25 |
| 3 lb | Sodium bicarbonate, powdered, pure | .25 |
| 2 lb | Sodium bisulphite, pure | .50 |
| 10 lb | Sodium carbonate, anhydrous | 3.00 |
| 5 lb | Sodium chloride, crystalline | .50 |
| 2 lb | Sodium citrate, powdered, pure | 2.00 |
| 1 lb | Sodium desoxycholate | 14.00 |
| 2 lb | Sodium dichromate, cryst, pure | 1.00 |
| 2 lb | Sodium fluoride, powdered, pure | 3.00 |
| 1 lb | Potassium chloride, cryst, pure | .25 |
| 2 lb | Sodium (di), hydrogen phosphate (Sorensen's salt), pure | .50 |
| 2 lb | Sodium hydroxide, pellets, pure | 2.00 |
| 2 lb | Sodium nitrate, cryst, pure | .50 |
| 2 lb | Sodium nitrite, cryst, pure | 1.00 |
| | Carried forward | 132.75 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 132.75 |
| ½ lb | Sodium nitroprusside, pure | 2.00 |
| 2 lb | Sodium oxalate, cryst, AR | 4.00 |
| 1 lb | Sodium potassium tartrate (Rochelle salt) | .50 |
| 1 lb | Sodium sulphate, cryst, pure | .25 |
| 1 lb | Sodium sulphide, cryst, pure | .25 |
| 1 lb | Sodium sulphite, cryst, pure | .25 |
| ½ lb | Sodium taurocholate | 3.00 |
| 2 lb | Sodium thiosulphate, cryst, pure | .50 |
| 2 lb | Sodium thiosulphate, cryst, AR | 1.00 |
| 2 lb | Sulphur, roll | .25 |
| 1 oz | Thallium acetate, pure | 3.00 |
| 1 lb | Zinc acetate, cryst, pure | .50 |
| 1 lb | Zinc carbonate, pure | .50 |
| 1 lb | Zinc oxide | .50 |
| | Total | 149.25 |

(b) Organic.

| | | |
|---|---|---|
| 2 winch | Acetone, rectified, pure | 3.00 |
| 3 winch | Acid, acetic, glacial | 7.00 |
| 2 oz | Acid, amo, pacetoc, cryst, pure | 2.00 |
| 2 lb | Acid, carbolic, pure | 1.00 |
| 1 lb | Acid, citric | .50 |
| 1 lb | Acid, lactic | 1.00 |
| 2 lb | Acid, picric, moist, cryst | 3.00 |
| 1 oz | Aesculin | 12.00 |
| 7 lb | Agar-agar fibre | 15.00 |
| 2 lb | Albumen, egg | 2.00 |
| 5 gal | Alcohol, ethyl, absolute | 7.00 |
| 2 gal | Alcohol, methyl, pure | 2.00 |
| 6 gal | Alcohol, ethyl, methylated spirit, 64% | 4.00 |
| 2 gal | Alcohol, ethyl, rectified spirit, 90% | 1.00 |
| 2 lb | Alcohol, isopropyl | 2.00 |
| 1 lb | Amiline, redistilled, pure | 1.00 |
| ¼ lb | Asparagine, pure | 12.00 |
| 2 winch | Benzene, crystallizable | 2.00 |
| 5 lb | Casein, edible quality | 4.00 |
| 5 lb | Chloroform | 5.00 |
| 1 oz | Dimethyl-p-phenylene diamine, pure | 4.00 |
| 2 oz | p-dimethyl aminobensaldehyde, pure | 4.00 |
| 1 lb | Dioxan, pure | 2.00 |
| 4 winch | Ether, 0.73 | 4.00 |
| 6 winch | Formaldehyde soln, 40% | 6.00 |
| 5 lb | Gelatine, bacteriological quality, sheets | 10.00 |
| 500 g | Glycerine-albumen | 2.00 |
| 5 winch | Glycerol, redistilled | 14.00 |
| ½ lb | α-Naphtol | 2.00 |
| 2 winch | Paraffin, liquid | 4.00 |
| 3 lb | Plasticine | 1.00 |
| 1 lb | Pyridine, pure | 3.00 |
| 1 lb | Pyrogallol, sublimed, pure | 4.00 |
| ½ lb | Starch, potato | .25 |
| ½ lb | Starch, soluble, Lintner's | .50 |
| 1 lb | Urea, pure | .50 |
| 4 boxes | Urease, boxes of 40 tablets, pure | 10.00 |
| 1 lb | Vaseline, white | .25 |
| 2 lb | Vaseline, yellow | 1.00 |
| 7 lb | Wax, paraffin, MR 56° C | 2.00 |
| 7 lb | Wool, cotton, coloured, non absorbent | 4.00 |
| | Carried forward | 165.00 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 165.00 |
| 14 lb | Wool, cotton, white, no. 1 quality | 17.00 |
| 4 winch | Xylene, pure | 8.00 |
| | Total | 190.00 |

(c) Indicators.

| | | |
|---|---|---|
| 5 g | Bromocresol purple, pH range 5.6-6.8 | 4.00 |
| 5 g | Bromophenol blue, pH range 2.8-4.6 | 3.00 |
| 5 g | Bromothymol blue, pH range 6.0-7.6 | 4.00 |
| 5 g | Cresol red, pH range 7.2-8.8 | 4.00 |
| 5 g | Haematoxylin, pH range 5.0-11.0 | .50 |
| 100 g | Litmus, pH range 4.5-6.5 | 1.00 |
| 5 g | Methyl red, pH range 4.4-6.0 | .50 |
| 100 g | Phenol phtalein, pH range 8.3-10.0 | 3.00 |
| 5 g | Phenol red, pH range 6.6-8.0 | 2.00 |
| 5 g | Thymol blue, acid, pH range 1.2-2.8 | 3.00 |
| 5 g | Thymol blue, alkaline, pH range 8.0-9.6 | 3.00 |
| 500 cc | Universal indicator (B.D.H.), pH range 3.0-11.0 | 3.00 |
| | Total | 31.00 |

(d) Sugars.

| | | |
|---|---|---|
| 10 g | Arabinose | 4.00 |
| 1 kg | Dextrose (glucose) | 2.00 |
| 100 g | Inuline | 2.00 |
| 100 g | Invert sugar | .25 |
| 1 kg | Lactose | 1.00 |
| 250 g | Laevulose (fructose) | 2.00 |
| 500 g | Maltose | 10.00 |
| 500 g | Mannitol | 6.00 |
| 10 g | Raffinose | 8.00 |
| 100 g | Salicin | 2.00 |
| 5 g | Trehalose | 11.00 |
| | Total | 48.25 |

(e) Stains.

| | | |
|---|---|---|
| 50 g | Aniline blue | 2.00 |
| 50 g | Bismarck brown (vesuvine) | 2.00 |
| 50 g | Brilliant green | 2.00 |
| 50 g | Brilliant vital red | 11.00 |
| 2 lb | Brunswick black | 4.00 |
| 50 g | Congo red | 2.00 |
| 50 g | Crystal violet | 3.00 |
| 50 g | Eosin, alcohol soluble | 3.00 |
| 50 g | Fluorescin | 2.00 |
| 50 g | Fuchsin, basic, magenta | 2.00 |
| 50 g | Gentian blue | 2.00 |
| 50 g | Giemsa's stain | 15.00 |
| 50 g | Haematoxylin | 4.00 |
| 50 g | Leischmann's stain | 8.00 |
| 50 g | Malachite green (Victoria green) | 2.00 |
| 50 g | Methylene blue | 2.00 |
| 50 g | Neutral red (totylene red) | 4.00 |
| 50 g | Nigrosine | 1.00 |
| 50 g | Orange II | 2.00 |
| 50 g | Safranin o | 2.00 |
| 50 g | Thionine (Lauth's violet) | 17.00 |
| 50 g | Wright's blood stain | 8.00 |
| | Total | 100.00 |

(f) Oils and mounting media.

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 7 lb | Canada balsam in xylol | 26.00 |
| 500 g | Cement cover glass (Kronig) | 4.00 |
| 1 kg | " Lenzol " immersion oil | 10.00 |
| | Total | 40.00 |

(g) Culture media.

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 3 doz | Blood serum, Loeffler's, in tubes | 4.00 |
| 25 g | l-cystine | 11.00 |
| 3 lb | Peptone, bacteriological quality | 25.00 |
| | Total | 40.00 |

(h) Dehydrated media.

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 250 g | Agar, McConkey's | 8.00 |
| 250 g | Agar, nutrient | 7.00 |
| 250 g | Beef extract | 4.00 |
| 250 g | Beef heart, for infusion | 4.00 |
| 250 g | Broth, McConkey's | 6.00 |
| 250 g | Broth, nutrient | 11.00 |
| 250 g | Gelatine, nutrient | 5.00 |
| 250 g | Lactose peptone bile | 5.00 |
| 250 g | Litmus milk | 3.00 |
| 250 g | Liver | 5.00 |
| 250 g | Yeast extract | 4.00 |
| | Total | 62.00 |

# GENETICS

A. Course Content (given only as an example to facilitate the use of the inventories).

*General training.*

Experimental analysis of genetical inheritance : Mono, poly-hybridism. Extension of Mendelism. Types of action of heredity factors. Interactions. Quantitative heredity. Sex determinism.

The physical basis of heredity: Chromosomes and genes. Linkage. Genetical balance. Sex-linked heredity. Crossing-over (genetical, cytological). Establishment of chromosome charts. Giant chromosomes.

Heredity variation: Mutation. Different types. Natural mutations. Experimental mutations (production, detection). Mutation of genes, chromosomes, genomes. Allopolyploidy. Polysomy. Structural hydridity.

Activity of genes and cycloplasm: Heterosis. Morpho-genesis. Phenogenetics. Cytoplasmic heredity.

Elements of human genetics.

Ideas on the evolution of organized beings: facts and theories. Origin and fate of species.

*Special training.*

Applied genetics and the improvement of cultivated plants. Genetical processes in the formation of cultivated plants. Biological characteristics. Quantitative heredity. Multiplication. Reproduction. Auto- and allo-gamy. Heterosis. General methods and techniques of improvement. Special genetics of the principal cultivated plants. Particular techniques of improvement. Cytoplasmic heredity. Genetic effects of radiations and mitagenetic agents. Genetics of bacteria and bacteriographs. Origin and evolution of cultivated plants, etc.

## B. LABORATORY WORK.

*General training.*

Examination of microscopical preparations (mitoses, meioses, sexual chromosomes, giant chromosomes). Studies of disjunctions, facts of sex-linked heredity.
Linkage. Recombinations.

*Special training.*

(a) Application of techniques in the field and in the laboratory (biometry, crossings, disjunctions, comparative trials). Visits to public or private research or breeding establishments.
(b) Study of descent (plants, Drosophilae, Mice, etc.). Establishment of chromosome charts. Use of radiations and mutagenic agents. Mutation detection. Microscopic examinations. Comparative trials, etc.

Students have to carry out literature researches and present literature reviews on given subjects.

## C. EQUIPMENT.

(1) *Demonstration apparatus.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 500 | Diapositives | — |
| 300 | Wall pictures | — |
| 1 colln | Specimens preserved for their genetical interest (ears of Gramineae, fruits, Drosophilae, etc.) | — |

(2) *Laboratory apparatus* (per group of 10 students).

| | | |
|---|---|---|
| 5 | Binocular microscopes obj 1.8×, 3.5×, 7×; eyepiece 6×, 10×, 14×, 20× | 832.00 |
| 10 | Microscopes, obj 3×, 5×, 7×; eyepiece 5×, 8×, 10×; with apochromatic immersion objectives $^1/_{12}$ and $^1/_{15}$ | 4,000.00 |
| 10 | Lamps for microscopes, 15 W, 110 V | 40.00 |
| 1 | Fombrune micro-manipulator | 723.00 |
| 1 | Lamp and accessories for fluorescent microscope | 67.00 |
| 1 | X-ray emission apparatus | 32.50 |
| 1 | Ultra-violet ray emission apparatus | 170.00 |
| 2 | Microfilm readers | 400.00 |
| 1 | Precision balance, 200 g, $^1/_{10}$ mg | 208.00 |
| 1 set | Weights for above | 16.00 |
| 5 | Congelation microtomes | 750.00 |
| 2 | Hot plates, 3 heat settings | 20.35 |
| 10 | Porcelain plates for mixing stains, with 6 depressions | 8.60 |
| 10 | Desiccators, flat ground lid with knob, 150-200 mm diam | 50.00 |
| 1 | Oven, 45° C, 25 × 25 × 25 cm | 85.00 |
| 1 | Oven, 24° C, 48 × 40 × 60 cm | 119.00 |
| | Carried forward | 7,521.45 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 7,521.45 |
| 3 | Bunsen burners | 2.70 |
| 10 | Alcohol lamps, brass | 9.00 |
| 2 | Etherisers | .50 |
| 1 | Photographic enlarger | 100.00 |
| 1 | Calculating machine, capacity 10 × 11 × 20; automatic multiplication and division; electric | 790.00 |
| 1 | Thermometer, —10 to + 150° C | 1.50 |
| 1 | Time switch | 10.00 |
| | Total | 8,435.15 |

(3) *Individual equipment* (per student).

| | | |
|---|---|---|
| 1 | Dissection set (scalpels, forceps, scissors, needles, etc.) | 6.60 |
| | Total | 6.60 |

(4) *Glassware.*

| | | |
|---|---|---|
| 1 | Beaker, P, 400 cc | .26 |
| 20 | Petri dishes, 100 × 15 mm | 4.20 |
| 1 | Graduated test tube, 1,000 cc | 3.00 |
| 1 | Graduated test tube, 500 cc | 2.25 |
| 1 | Erlenmeyer flask, 1,000 cc | .55 |
| 1 | Erlenmeyer flask, 500 cc | .35 |
| 500 | Microscope slides | 78.50 |
| 5,000 | Cover slips | 8.75 |
| 1 | Distilled water container, 10 l | 6.40 |
| 80 | Test tubes, 10 × 2 cm | 3.00 |
| | Total | 107.26 |

(5) *Chemicals.*

| | | |
|---|---|---|
| 1,000 cc | Acid, acetic | 1.10 |
| 1,000 cc | Acid, hydrochloric, normal | 1.70 |
| 500 g | Albumen, egg | 4.00 |
| 2,000 cc | Alcohol, ethyl, absolute | 12.00 |
| 2,000 cc | Alcohol, ethyl, 95° | 11.00 |
| 50 cc | Balsam, Canada | .50 |
| 50 cc | Cedar oil | .60 |
| 250 cc | Erythrosine | 1.25 |
| 250 g | Flour, maize | .25 |
| 50 g | Gelose | .50 |
| 250 cc | Gentian violet | 13.50 |
| 250 cc | Lacmoid, soln | 1.00 |
| 100 cc | Lugol, soln | .85 |
| 250 cc | Saccharose | .70 |
| 250 cc | Schiff's soln | 1.00 |
| 2,000 cc | Toluene | 2.00 |
| | Total | 51.95 |

## THIRD PART

# TECHNICS

# RURAL ELECTROTECHNICS

A. Course Content (given only as an example to facilitate the use of the inventories).

(1) Direct current machines and equipment: D.C. generators and motors. Distribution of direct current. Accumulators.
General properties of alternating currents: Effective intensity and voltage. Self induction and capacity. Impedance. Resonance. Power factor. Active and reactive energy and power.
Alternating current machines and equipment: alternators. Transformers. Three and two-phase currents. Synchronous motors. Asynchronous motors. Collector motors. Transport of electrical energy to a distance. Transformation of alternating into direct current.
Electrical measurements: Amperemeters, voltmeters, wattmeters, consumption meters.
Applications: Lighting. Electric heating. Tarification.
(2) Electrostatics: Conductors. Potentials. Capacity. Condensers. Electrostatic energy. Electrokinetics.
Magnetism: Field. Magnetization. Leaf magnets.
Electromagnetism: Field due to electric current. Magnetic circuit. Electromagnet. Electro-magnetic force. Induction. Systems of units.
Dynamos.
Alternating currents: Alternators. Transformers. Polyphase currents. Synchronous and asynchronous motors.

B. Practical Work.

*Testing of machines.*

Generator with separate excitation.
  Determination of the excitation curve.
  Determination of the load characteristic.
Direct current motors.
  Speed-load characteristic of a shunt motor.
  Speed-load characteristic of a series motor.
Transformer.
  Transformation ratio.
  No load tests.
  Iron losses and power factor.
  Test under load-regulation curves.
  Measurement of efficiency.
Asynchronous motor.
  Starting. Reversal.
  Variation of slip and of power factor with load.
  Measurement of output under full load.

*Electrical measurements.*

Resistances, self-inductances, capacities, electromotive force, reactance, etc.

C. Equipment.

*For practical work* (per group of 25 students).

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 10 | Direct current shunt motors, 27 A, 115 V, 2 kW, 1,300 rpm | 1,430.00 |
| 6 | Series motors, 115 V, 1,500 rpm . . . . . | 860.00 |
| 6 | Asynchronous motors, 220 V, 1,580 rpm . . . | 430.00 |
|  | Carried forward | 2,720.00 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 2,720.00 |
| 6 | Transformers, 50 cycle, 2 kW, primaru 220 V, secondary 110 V | 175.00 |
| 6 | Rheostats for starting | 50.00 |
| 12 | Field rheostats | 105.00 |
| 5 | Charging rheostats | 358.00 |
| 12 | Ammeters, 10, 20 and 50 A | 240.00 |
| 12 | Voltmeters | 240.00 |
| 12 | Wattmeters | 1,715.00 |
| 1 | Autotransformer | 150.00 |
| 7 | Tachometers | 378.00 |
| 1 | Universal controller | 50.00 |
| 1 | Rectifier, 20 kW | 2,290.00 |
| | Total | 8,471.00 |

# APPLIED MECHANICS AND AGRICULTURAL WATER SUPPLIES

A. Course Content (given only as an example to facilitate the use of the inventories).

*Applied mechanics.*

Introduction: Review of essential concepts of rational mechanics. Dynamics of material systems. Law of transformation of various kinds of mechanical energy. Principle of conservation of mechanical energy.

Nomography: its aim. Graphical statistics. Instruments: Slide rules. Planimeter.

Passive resistances: Sliding friction. Rolling friction. Rigidity of ropes. Fluid resistances. Impacts.

Machines: application of the theorem of live force to the different phases of the operation of a machine. Efficiency. The flywheel.

Transmissions: transmission shafts. Bearings, couplings. Clutches. Cone and ball bearings. Gears. Flexible drives. Crankshaft system. Cams and eccentrics. Fluid transmission.

Strength of materials: Definition and hypothesis. Deformations of homogenous materials (extension, compression, shearing, plane flexure, torsion). Deformations of heterogenous materials (masonry, reinforced concrete).

Thermodynamics: Steam engines. Internal combustion engines. Thermodynamic tests of heat engines. Cost of energy obtained.

*Agricultural water supplies.*

Mechanics of liquids: Hydrostatics. Hydrodynamics. Hydraulics. Flow through orifices, weirs, discharge pipes, flow under pressure through pipes of constant cross-section and through channels; subterranean hydraulics.

Hydraulics of watercourses: Feeding and formation of stream bed. Measuring the flow of a stream. Average flows, lowest water levels, and flood waters. Carrying down of solid materials. Upkeep and improvement of the stream bed. Protection of the banks.

Water as a source of mechanical energy. Arranging a waterfall. Hydraulic motors.

Water supplies for men and animals: Amounts of water necessary. Arrangement of supply points. Transporting water. Water storage. Water distribution. Administrative and financial problems of supplying piped water to a rural area.

Water supplies for crops: (1) Irrigation: Advantages of irrigation. Quality of waters to use. Amounts of water necessary for irrigations. Distribution of water for irrigation. Means of obtaining water for irrigation. Sale of water. Partitioning, devices and modules. Methods and systems of irrigation. Irrigation practice for different crops. Irrigation economics. (2) Land improvement: Agricultural improvement. Drainage.

### B. Practical Work.

Applied mechanics: Slide rule, planimeter, sliding friction, gear trains.

Thermodynamics: Indicated power of a steam engine (Watt's indicator). Effective horse-power of heat engines; Prony brake. Band brake, spring transmission dynamometer.

Hydraulics: Flow through orifices, discharge pipes, weirs, sluices, pressurized pipes. Measurement of flow of a stream. Measurement of output of a well with the help of limnigraphs. Measurement of velocity of percolation through dry soil.

Supplementary work (in the lecture theatre): Correction of problems on strength of materials and hydraulics. Film shows.

### C. Equipment.

(1) *Demonstration equipment.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 colln | Models of couplings, clutches and joints | 100.00 |
| 1 colln | Models of demounted oilers | 70.00 |
| 1 colln | Models of simplified gears and gear trains | 60.00 |
| 1 colln | Pulleys and ropes | 30.00 |
| 1 colln | Orifices for flow measurement | — |
| 1 colln | Isolated samples of piping, joints, connexions, cast bends, steel, asbestos, cement | — |
| 50 | Wall pictures | — |
| 1 colln | Photographs | — |
| 1 colln | Diapositives | — |
| 200 | Drawings with descriptions for distribution to students | — |
| 1 colln | Small scale models of turbines | 100.00 |
| | Total | 360.00 |

(2) *For practical work.*

| | | |
|---|---|---|
| 30 | Drawing boards | 200.00 |
| 10 | Slide rules, 35 cm long | 120.00 |
| 30 | Slide rules, 27 cm long | 210.00 |
| 3 | Micrometers | 50.00 |
| 5 | Vernier calipers | 100.00 |
| 30 | Polar planimeters | 1,750.00 |
| 1 | Planimeter for Watt's diagram | 70.00 |
| 2 | Tables for the study of sliding friction with bed and material | 80.00 |
| 3 | Roberval balances | 80.00 |
| 2 | Fixed cylinders with bed | 120.00 |
| 1 | Vertical steam engine, single cylinder, 9 HP, 220 rpm | 1,750.00 |
| 1 | Watt's indicator, complete | 60.00 |
| 1 | Tubular boiler, 300 kg of steam per hr, 8 hp, heated surface 13.2 $m^2$ | 1,200.00 |
| 1 | Prony brake | 20.00 |
| 3 | Tachometers | 160.00 |
| 3 | Revolution counters | 26.00 |
| 10 | Chronometers | 57.00 |
| | Carried forward | 6,053.00 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 6,053.00 |
| 1 | Diesel engine, 4 speeds, 9 HP, 1,200 rpm | 150.00 |
| 1 | Band brake | 10.00 |
| 1 | Petrol engine, 4 speeds, 8 HP, 1,200 rpm | 115.00 |
| 1 | Belt dynamometer | 85.00 |
| 1 | Grinder for broom branches, 3 HP | 45.00 |
| 10 m | Belting | 50.00 |
| 1 | Dynamometric crank | — |
| 1 | Metal tank, 1.5 × 3 m | 175.00 |
| 1 colln | Orifices and discharge pipes, brass | 150.00 |
| 2 | Reinforced concrete pits, set into earth, 5 and 1.5 $m^3$ | — |
| 1 | Buried cement conduit, 12 m long, 30 cm wide, 30 cm deep (for hydraulic experiments) | — |
| 1 colln | Various brass plates (weirs, sluices, etc.) | 30.00 |
| 2 sets | Canalizations, steel tubing, 12 m long, 35 cm diam with various bends and piezometric tubes | 60.00 |
| 6 | Water meters, 40 cm diam | 175.00 |
| 1 | Pitot tube | 35.00 |
| 1 | Voltmann water meter | 60.00 |
| 1 | Ott water meter, with arrangement for electric contact | 230.00 |
| 2 | Limnigraphs, recording | 300.00 |
| 2 | Limnigraphs, electric | 230.00 |
| 4 | Electric pump sets, delivery 3 l/sec at 10 m, 2-3 HP | 460.00 |
| 2 | Drills | 80.00 |
| | Total | 8,493.00 |

# STRENGTH OF MATERIALS

A. Course Content (given only as an example to facilitate the use of the inventories).

Elements of the theory of elasticity; formulae for plane elasticity. Hypothesis about the laws of strength of materials. Definition of simple deformations. Normal flexion. Buckling. Mohr's method of representation. Intrinsic curves. Experimental measurement of constraints. Bases of photo-elasticity measurement. Graphical statics. Isostatic and hyperstatic constructions. Navier-Bresse formula. Isostatic, hyperstatic and continuous straight beams. Masonry, dam walls, concrete, reinforced concrete. Calculation of arcs and frameworks. Methods of calculation based on the work of deformation. Mobile loads, methods of lines of influence. Soil mechanics. Equilibrium of ramparts, retaining walls, foundations, silos.

B. Practical Work.

Six sessions.

# AGRICULTURAL ENGINEERING IN THE TROPICS

Course Content (given only as an example to facilitate the use of the inventories).

Need for correcting or combining the natural elements in production: men, water, soil, etc. Topographical surveys, technique and practice of land clearing, establishment of irrigation systems, drainage, hydraulic works. Material used for these different activities, use and yield.

Need for the introduction of mechanization or at least of partial mechanization of cultural practices because of low density of population, difficulty of working in a rigourous climate and shortage of the various materials used, preparation of the soil, sowing, cultivation, harvesting, etc. Detailed study of three main crops: Rice by inundation, cotton by irrigation, ground-nuts on dry land.

Need for struggle against soil impoverishment and erosion, and for the maintainance of soil fertility. Principles and techniques used, terrace cultivation, water percolation, wind-breaks, spreading of fertilizers, etc.

Communications, making roads and tracks, river transport. Description of materials used, conditions of use and yield.

Drinking water supplies, construction of wells, tapping of springs, reservoirs.

Rural material. Living quarters, crop stores, repair workshops, etc.

General principles of building, utilization of local materials (chalk, bricks, tiles, etc.).

## RURAL BUILDING

Course Content (given only as an example to facilitate the use of the inventories).

Design of farm buildings and its influence on farming: commodities, cost price, yield. Principal materials used in agricultural building; advantages and disadvantages. Most hygienic general arrangements. Interior design: cleanliness, ease for working, reduction of feeding stuff losses, recovery of waste materials, etc. The main farm buildings: dwelling house, animal's quarters, storage for crops, storage for cultivation implements. Economics of farm buildings: cost, upkeep, depreciation, building incentives.

## GENERAL ARCHITECTURE

A. Course Content (given only as an example to facilitate the use of the inventories).

Allocation of contracts, tenders, price-lists. General composition. Town planning. Foundations. Testing materials. Sands. Binding materials (ordinary and hydraulic). Mortars and cements. Plasters. Masonry. Quarrystone. Stones. Bricks. Reinforced, pre-stressed concrete. Modern materials. Framework. Staircases. Pavements. Facings. Doors and floors. Coverings. Terraces. Carpentry. Plumbing. Sanitation. Heating. Painting.

B. Practical Work.

Three practical exercises; 5 visits to workshops or laboratories.

# METALLURGY

A. Course Content (given only as an example to facilitate the use of the inventories).

Composition of metals and alloys. Structure. Micrography. Macrography. Fractography. Radio-metallography. Micro-metallography. Physical methods for the study of alloys. Elements added to steels. Different types of steels. Cast iron: composition, structure, different types of castings. Copper and its alloys. Aluminium and its alloys. Refractory melts. Special alloys. Cast iron and steel founding. Forgeing, working of sheet metal, machining. Methods of joining metals. Surface treatment.

B. Practical Work.

Five factory visits.

# WOOD TECHNOLOGY

A. Course Content (given only as an example to facilitate the use of the inventories).

Constitutent elements of wood. Technological faults, deterioration, and classification. Physical and mechanical properties according to the various methods of stressing. Durability of timbers: natural and artificial seasoning. Antiseptics. Principal imported and native colonial species. Timber for the construction of frameworks, machinery, agricultural and industrial implements.

B. Practical Work.

Four sessions.

# CO-OPERATIVE INSTALLATIONS

Course Content (given only as an example to facilitate the use of the inventories).

Generalities concerning projects for industrial installations.
Auxiliary tools, handling and transport of solids and liquids.
Mechanical installations.
Dairying works: general, butter factories, dairies, cheese factories.
Cider, wine cellars.
Silos, stores, fruit packing stations.
Slaughterhouses.

# AGRICULTURAL MACHINES

A. Course Content (given only as an example to facilitate the use of the inventories).

*Agricultural machines.*

Generalities.
Agricultural machine industry.
Elements of metallurgy.
Conditions of utilization of machines.
Precultural work.
Plough: Soil resistance; study of the different parts of the plough; stability and setting; classification.
Machines for stimulating tillage.
Machines for spreading fertilizers; liquid, solid, powder fertilizers.
Sowing machines.
Machines for crop maintenance.
Machines for harvesting fodder: mowers, haymakers, rakes, tedding by driers and stooks, artificial tedding, machines for bringing in fodder.
Reaper binder.
Threshing machine.

*Engines.*

Animal driven.
Wind driven.
Steam engines: cycles, boilers, distribution system, controls, condensers, safety devices.
Steam turbines.
Internal combustion engines: cycles, cylinder head, cylinder piston, piston-ring, piston-rod, crankshaft, flywheel, chassis, distribution, carburation (vaporization, diagrammatic, carburettor, automaticity, other carburettor characteristics); fuel and air feeds, ignition (magneto, battery, sparking plug, ignition advance); cooling speed regulation, lubrication, 2-stroke engines, fuels (petrol, substitute fuel); gas generators.
Diesel engine: cycle, injection, injection apparatus.
Semi-Diesel engine.
Hydraulic engines.

*Power agriculture.*

General considerations.
Power agriculture in England, France, Union of Socialist Soviet Republics and United States of America.
Soil mechanics.
Tractor.
Power-driven cultivator.
Self-propelling machines.
Cable systems.
Tilling in power agriculture: ploughs, organization of tillage.
Agricultural vehicles.
Machines for eradicating weeds.
Potato cultivation.
Harvester-thresher.
Tyres for field work.

B. Practical Work.

(1) Fixed farm machinery (description, functioning and control). Pumps. Practical study of machines in the institute or on the farm after they have been discussed in the course.

(2) General study of an engine on a sectioned " Bernard " engine.
Practice in dismantling and re-assembly.
Study of the main parts.
Films.

C. EQUIPMENT.

(1) *Demonstration apparatus.*

(a) For the first part of the course " Agricultural Machinery ".

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 | Scale model of a plough | — |
| | Parts of machine's actual size: sowing machine, mower | — |
| 1 colln | Scale models of the most important machines (part of the " box " of the threshing machine in transparent material) | — |
| 1 colln | Parts of machines or complete mechanisms (e.g. binding platform) | — |
| 1 colln | Descriptive pictures, coloured | — |

(b) For the second part of the course " Engines ".

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 colln | Half sectioned engines, various types. | — |
| 1 | Injector and injection pump | — |
| 1 colln | Separate parts and pieces of engines | — |
| 1 colln | Complete engines of different types for dismantling and re-assembly | — |
| 1 colln | Films | — |
| 1 colln | Blueprints of engines and engine parts | — |

(c) For the third part of the course " Power Agriculture ".

Farming machines

(2) *Equipment for practical work.* [1]

(a) Cultivating and harvesting machinery.

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 | Plough, Brabant, simple | 90.00 |
| 4 | Ploughs, Brabant, double, various sizes | 400.00 |
| 1 | Plough, simple, automatic raising, double share | 250.00 |
| 1 | Plough, simple, automatic raising, quadruple share | 600.00 |
| 1 | Plough, simple, automatic raising, 5 shares | 300.00 |
| 1 | Plough, balance type, 3 shares | 720.00 |
| 1 | Cultivator, automatic raising, 9 toothed | 260.00 |
| 1 | Cultivator, automatic raising, 11 toothed | 300.00 |
| 1 | Cultivator, animal drawn, 7 toothed | 100.00 |
| 1 | Disc harrow, 16 discs | 570.00 |
| 1 | Disc harrow, 20 discs | 620.00 |
| 5 | Harrows, various types | 450.00 |
| 2 | Hoes | 150.00 |
| 1 | Ridger, for beet, fitting on a hoe | 10.00 |
| 1 | Mechanical hoe, horse drawn | 30.00 |
| 1 | Mechanical hoe, tractor drawn | 400.00 |
| 1 | Ridger, for potatoes, tractor drawn | 190.00 |
| 1 | Furrower, for potatoes, tractor drawn | 190.00 |
| 2 | Rollers | 200.00 |
| | Carried forward | 5,830.00 |

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[1] Certain of the apparatus listed above is also used for practical work. The variety of the material and the quantity of agricultural machines obviously depend on the size of the experimental farm attached to the school.

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 5,830.00 |
| 1 | Sower, single seed, tractor drawn, 4 drills | 550.00 |
| 1 | Sower, for cereals, tractor drawn, 11 drills | 350.00 |
| 1 | Sower, for cereals, tractor drawn, 19 drills | 680.00 |
| 1 | Crosskill | 150.00 |
| 1 | Fertilizer spreader, animal drawn | 200.00 |
| 1 | Sprayer, for treatment of potatoes | 1,000.00 |
| 1 | Liquid manure barrel, pneumatic tyres | 150.00 |
| 1 | Harvester for sugar beet | 1,450.00 |
| 1 | Harvester for potatoes | 250.00 |
| 1 | Combine harvester with bagger | 3,000.00 |
| 1 | Reaper-binder, tractor drawn | 650.00 |
| 2 | Rakes, animal drawn | 190.00 |
| 1 | Hay rake | 200.00 |
| 2 | Haymakers | 215.00 |
| 1 | Reaper, 2 horses | 150.00 |
| 1 | Reaper, tractor drawn | 300.00 |
| | Total | 15,315.00 |

(b) Traction and transport equipment.

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 | Tractor 22/30 HP | 1,672.00 |
| 1 | Tractor 36/40 HP | 3,550.00 |
| 1 | Tractor 13/18 HP | 1,383.00 |
| 1 | Trailer, for tractor, pneumatic tyres, for 6 metric tons, 4.60 × 2.10 m | 1,000.00 |
| 1 | Trailer tipping both sides, pneumatic tyres, for load of 4.5 metric tons, 4 × 2 × 0.45 m | 1,300.00 |
| 1 | Tipcart, pneumatic tyres, brake, load 1,700 kg | 330.00 |
| 1 | Tipcart, pneumatic tyres, brake, load 2,700 kg | 490.00 |
| 1 | Tipcart, pneumatic tyres, brake, load 4,500 kg | 780.00 |
| 1 | Tipcart, pneumatic tyres, brake, removable sides, load 2,700 kg | 650.00 |
| 1 | Fodder cart, pneumatic tyres, load 3 t | 565.00 |
| 1 | Fodder cart, pneumatic tyres, load 5 t | 820.00 |
| 1 | Fodder cart, pneumatic tyres, load 8 t | 1,360.00 |
| 1 | Cattle cart | 250.00 |
| 1 | Milk cart | 300.00 |
| | Total | 14,450.00 |

(c) Farm machines.

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 | Treshing machine 20 quintals per hour | 8,000.00 |
| 1 | Straw elevator | 285.00 |
| 1 | Straw presser | 358.00 |
| 1 | Straw trusser | 264.00 |
| 1 | Hay elevator | 300.00 |
| 1 | Potato sorter with inspection table, 3 t per hour | 300.00 |
| 1 | Small grain sorter | 572.00 |
| 2 | Winnowing machines | 120.00 |
| 1 | Liquid manure pump, electric, not automatic | 130.00 |
| 4 | Silos (cement construction) | — |
| | Total | 10,329.00 |

(d) Apparatus for the preparation of feeding stuffs.

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 | Crusher, with motor | 100.00 |
| 1 | Hammer grain mill, with 6 HP electric motor, 1,450 rpm | 385.00 |
| 1 | Oilcake crusher | 650.00 |
| 1 | Root cutter, without motor | 25.00 |
| 1 | Potato steamer | 30.00 |
| | Carried forward | 1,190.00 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 1,190.00 |
| 1 | Straw chopper, without motor | 35.00 |
| 1 | Tuber washer | 108.00 |
| 1 | Sack hoist | 65.00 |
| 1 | Flour mill with motor | 172.00 |
| 1 | Mixer, 400 l, with 50 HP motor, 950 rpm, 220 or 380 V | 825.00 |
| | Total | 2,395.00 |

# AGRICULTURAL INDUSTRIES

A. Course Content (given only as an example to facilitate the use of the inventories).

(1) Successive studies of the main agricultural industries, in the form of monographs: the industry in relation to the general economy. Study of raw materials. Physical, chemical, biological principles of the industry under consideration. Brief description of the principal procedures and equipment used. Study of by-products.

Industries studied: Dairy industries (see Dairying course). Wine (see Oenology course). Cider-making. Malting and brewery. Alcohol industries (distillery, absolute alcohol, spirits). Sugar refining. Milling and bakery. Starch industry. Oil industry. Preseriring. Tannery. Manufacture of fertilizers.

(2) Synthetic studies of the main problems of agricultural industries: transport of materials. Heating, refrigeration, freezing. Sub-division of materials. Separation of constituent elements by mechanical, physical, or chemical methods (e.g. sieving, decanting, filtration, crystallization, evaporation, distillation, condensation, etc.). Bringing substances into contact for mixture, dissolution, reactions. Control of industrial operations; balance sheet of manufacture, losses. Technical, economic, administrative, and financial conditions to be studied in setting up a factory. Organization and management of the concern.

B. Practical Work.

Projection of slides and films. Examination of collections. Study of plant. Visits to factories in the district.

Physical and physico-chemical work related to the course outlined above. Additional study of plant. Reports and discussions by the students on a given prepared subject.

C. Equipment.

(1) *Demonstration apparatus.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 200 | Wall pictures | — |
| 500 | Diapositives | — |
| 1 colln | Films on agricultural industries | — |

(a) Dairying.

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 | Cream separating bowl | 50.00 |
| 3 | Cream separators, various types, manually operated | 300.00 |
| 1 colln | Butter churns, various types | — |
| 1 | Butter worker | 24.00 |
| 1 | Aluminium drum, 10 l | 2.50 |
| 1 | Aluminium can | .50 |
| | Scale models: | |
| 1 | Milk filtering apparatus | — |
| 1 | Lawrence refrigerator | — |
| 1 | Schmith refrigerator | — |
| 1 | Corbin tube | — |
| 1 | Pasteurizer | — |
| 1 | Homogenizer | — |
| 1 | Autoclave | — |
| 1 colln | Tin-plated cheese moulds | 25.00 |
| | Total | 402.00 |

(b) Oenology.

| | | |
|---|---|---|
| | Scale models: | |
| 1 | Grape press | — |
| 1 | Sulphiting tank | — |
| 1 | Press pump | — |
| 1 | Pump | — |
| 1 | Pasteurizer | — |
| 1 colln | Small grape presses | — |

(c) Brewery and malting.

| | | |
|---|---|---|
| 1 colln | Various varieties of hops | — |
| 1 colln | Various varieties of barley | — |
| | Scale models: | |
| 1 | Vat | — |
| 1 | Filter press | — |

(d) Cider making.

| | | |
|---|---|---|
| 1 colln | Scale models of cider presses | — |

(e) Distillery and Sugar-refining.

| | | |
|---|---|---|
| | Scale models: | |
| 1 | Pillet rasp | — |
| 1 | Champenois rasp | — |
| 1 | Champenois column | — |
| 1 | Diffusion battery | — |
| 1 | Philippe filter | — |
| 1 | Triple effect evaporator | — |
| 1 | Sugar centrifuge | — |
| 1 | Sugar densimeter | — |
| 1 colln | Sugar knives | — |
| 1 | Potato cooker | — |

(f) Milling and bakery.

| | | |
|---|---|---|
| | Scale models: | |
| 1 | Grain sorter | — |
| 1 | Chaff remover | — |
| 1 | Roughening tool | — |
| 1 | Roller mill | — |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 | Bolter | — |
| 1 | Starchmaking rasp | — |
| 1 | Chopin extensimeter | 300.00 |
| 1 | Baker's shovel | 2.00 |
| 1 colln | Mills | — |
| | Total | 302.00 |

(g) Oil industry.

| | | |
|---|---|---|
| | Scale models of Toulet mill | — |

(h) Miscellaneous.

| | | |
|---|---|---|
| 1 colln | Tools for resin tapping | — |
| 1 | Brake for textiles | — |

(2) *For practical work* (100 students in groups of 10).

(1) Apparatus.

| | | |
|---|---|---|
| 1 | Centrifuge, electric, 3,000 rpm, 4 pots of 15 cc | 58.00 |
| 1 | Centrifuge Gerber, electric, for butyrometer | 96.00 |
| 3 | Water baths | 200.00 |
| 8 | Thermometers, assorted | 16.00 |
| 6 | Bunsen burners | 5.40 |
| 2 | Gas rings | 13.00 |
| 1 | Evaporating dishes, porcelain, 1,500 cc | 17.50 |
| 40 | Evaporating dishes, porcelain, 20 to 250 cc | 10.00 |
| 3 | Ladles, enamelled | 4.50 |
| 2 | Skimmers, enamelled | 2.00 |
| 1 | Polarimeter, saccharimeter complete | 250.00 |
| 1 | Refractometer Abbé | 550.00 |
| 1 | Electric oven, 30 × 30 × 40 cm | 68.00 |
| 20 | Counterpoise boxes | — |
| 2 | Muffle furnaces | 35.00 |
| 1 colln | Densimeters | 30.00 |
| 1 | Precision balance, 200 g, sensitivity 0.05 mg | 175.00 |
| 1 set | Weights for above | 18.50 |
| 1 | Electric oven, 25 × 25 × 30 cm | 52.25 |
| 2 | Sandbaths, electric, 25 × 30 cm | 34.40 |
| 1 | Cream separator, electric, 530 litres per hour with motor | 320.00 |
| | Total | 1,955.55 |

(b) Glassware.

| | | |
|---|---|---|
| 3 | Burettes, Dornic, for sulphuric acid | 2.00 |
| 2 | Burettes, automatic, 11 cc | 20.00 |
| 2 | Burettes, automatic, 5 cc | 20.00 |
| 15 | Butyrometers | 22.50 |
| 10 | Cylinders, graduated, 10 cc | 8.20 |
| 5 | Bottles, 125 cc | 2.15 |
| 15 | Pipettes, 11 cc | 7.80 |
| 50 | Test tubes | 2.25 |
| 5 | Precipitation flasks, 125 cc | 1.80 |
| 20 | Glasses, 125 cc | 9.50 |
| | Total | 96.20 |

(c) Chemicals.

| | | |
|---|---|---|
| 5 l | Acid, hydrochloric | 3.00 |
| 1.5 l | Acid, sulphuric, d-1.84 | 3.00 |
| 500 cc | Alcohol, amyl | 1.30 |
| | Carried forward | 7.30 |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Brought forward | 7.30 |
| 250 cc | Guaiacol | 2.00 |
| 250 cc | Hydrogen peroxide | .30 |
| 5 l | Lead subacetate | 9.00 |
| 250 cc | Methylene blue | 1.50 |
| 250 cc | Phenolphtalein | 2.50 |
| 250 cc | Sodium hydroxide | .50 |
| | Total | 23.10 |

## DAIRYING

A. Course Content (given only as an example to facilitate the use of the inventories).

(1) Theoretical study of milk from physical, chemical, and biological points of view.
(2) Preparation of milk for human consumption: raw, pasteurized and sterilized milk.
(3) Preparation of buttermilk, sour milk, yoghourt, etc.
(4) Preparation of butter.
(5) Preparation of cheeses: fresh cheeses; ripened cheeses; soft, semi-soft, and hard cheeses.
(6) Preparation of ices and ice creams.
(7) Preparation of milk powder, evaporated and condensed milk.

B. Practical Work.

(1) Physico-chemical analyses of milk:
  (a) determination of density, viscosity, electrical conductibility, acidity, etc.
  (b) determination of fat, protein, sugar, content, etc.
(2) Physico-chemical analyses of butter, cheese, condensed milk, milk powder, ice creams, etc. Besides certain determinations mentioned under 1 above, these analyses will include specific determinations for each product, e.g. for butter: determination of the Reichert-Meisal index, the Polenske index, the saponification index, etc.
(3) Bacteriological analyses of milk, buttermilk, yoghourt, cheese, butter, etc. These include the determination of the number of bacteria, bacteria of the coli-aerogenes group, of proteolitic bacteria, of sporogenes, etc., as well as the determination of the different milk enzymes.

C. Equipment.

See "Agricultural Industries".

## OENOLOGY

A. Course Content (given only as an example to facilitate the use of the inventories).

General. Wine and wine industry.
Wine production. Characteristics of the wine industry. Wine. Oenology.
Principal factors affecting the quality of wine.

- Study of the raw material: the bunch of grapes.
  - Main constituent of must and wine.
  - Factors affecting quality of the raw material.
  - General composition of the grape.
  - Physico-chemical constitution of grape juice.
- Alcoholic fermentation.
  - Definitions and fundamental discoveries.
  - Historical: First period up to Buchner's discovery of zymase. In particular: Lavoisier's formula and Pasteur's theory. Second period: contemporary researches into the mechanism of alcoholic fermentation.
  - Explanation of the formation of secondary products; their importance.
  - Pasteur's material balance. Glycerol and ethanol. Acetic, lactic, citric and succinic acids.
  - Higher alcohols. Other secondary products.
  - Characteristics of alcoholic fermentation and alcohol yield (the relative interest of the latter in comparison with distillery practice).
- Alcoholic ferments.
  - General charasteristics of ferments (constitution, origin, classification, differentiation, selection, chemical composition).
  - Nutrition of the ferment.
  - Enzymes of alcoholic ferments (and other enzymes of interest as a source of vitamins). The ferment as a source of vitamins.
  - Influence of physical and chemical agents on the life of ferments.
- Wine making.
  - Preliminary operations.
  - Preparation of the building, vessels and instruments.
  - Grape harvest and picking: deciding the date on which to begin the harvest. Picking the grapes.
- Making of red wine (J. Ventre's method): mechanical treatment of the harvested grapes. Sulphite treatment. Addition of ferment. Fermentation in vats and correction of temperature. Removal from vats and pressing.
- White and rose wine making: general characteristics, fundamental differences from red wine making. Making wine from white grapes. Crushing. Draining. Pressing. Settling. Fermentation and treatment of the wine. Making white wine from red grapes. Principles. Local wines: Champagne. Principal technical precautions. Ordinary wines: Aramon from the South of France. Different processes, A. Bouffard and L. Semichon's process. Decoloration by filtration through animal charcoal. Rose wine making. Principle and practice. "Café" wines. General characteristics. Method of obtaining them. Rose wines and "Café" wines and legislation.
- Wine making from imperfect vintages: Insufficiently ripe grapes. Insufficiently acid grapes. Spoilt vintages, reasons for their being spoilt. Treatment.
  - Other methods of wine making: principles and technique; advantages and disadvantages. Cold maceration. Continuous fermentation. "Super quatre" fermentation (Semichon's process). Ethylene oxide. Treatment in vats with $CO^2$.
  - Classification of wines and special wine-making: Classification of wines. General characters and examples. Ordinary wines, high quality branded wines, named wines of restricted origin. Dry wines. Sweet, mellow, and liqueur-like wines. Sparkling and aerated wines. Liqueur wines, natural sweet wines and "Mistelles". Drinks with a wine base (vermouths, apéritifs), second wines made by gallization. Unfermented wines (fermentation checked by $SO^2$, by alcohol), their storage.
- Various microbial activities. Diseases and bad tastes in wines.
  - Study of aerobic ferments and their activities.
  - Study of anaerobic ferments and their activities.
  - Cloudiness in wines.
  - Tastes of wines.
- Wine preservation.
  - Drawing off and filling casks.
  - Clarification of wines. Fining. Wine filtration. Refrigeration. Concentration. Pasteurization. Blending. Oxygenation.

- Maturing of wines and bottling.
  - General characteristics of maturing. The bouquet. Phenomena of oxidation, reduction, esterification, precipitation.
  - Artificial maturing.
  - Bottling.
- Spirits and wine alcohols and by-products of the wine industry.
  - Spirits of wine: Cognac, Armagnac, Eaux de Vie from Southern France.
  - Proof spirit.
  - Redistilled alcohols.
  - Marc alcohols.
- Interest and general picture of by-products. Their possible destinations.
  - Marcs and residual liquids.
  - Alcohols from the lees.
- Grape juices and concentrated musts.
  - Grape juices: Operations preparatory to stabilization. Picking. Extraction. Clarification (cold, $SO_2$, centrifugal force, sining, pectin enzymes).
  - Different methods of stabilization, Pasteurization. Sterilizing filtration. Storage under $CO_2$ pressure. Various procedures.
  - Concentration of musts.
  - Different methods of preparation. Composition. Preservation and uses.

B. Practical Work.

- Analysis of musts:
  - Qualitative study of the constituents of the vintage.
  - Determination of density.
  - Calculation of the dry extract.
  - Refractometry of musts.
  - Determination of reducing sugars.
  - Determination of total acidity.
  - Determination of $SO_2$, free, total, combined (Rippert method).
- Analysis of wines:
  - Density and dry densimetric extract (extracts oenometer).
  - Determination of alcohol.
  - Determination of total acidity.
  - Determination of volatile acidity.
  - Determination of free acidity.
  - pH determination by means of the differential ionometer.
  - Determination of reducing sugars.
  - Determination of $SO_2$.
  - Determination of total tartaric acid.
  - Determination of total potassium.
  - Ash determination.
  - Determination of alkalinity of the ash.
  - Determination of sulphates.
  - Determination of total iron.
  - Determination of chlorides (Charpentier-Volhard).
  - Determination of tannoid substances.
  - Tests of stability in air and in the oven.
  - Tests with isinglass (clarifying).
  - Taking of samples for tasting.
- Experiments in microbiology:
  - Preparation of liquid and solid culture media.
  - Making of sterile pipettes.
  - Sterilization of culture media and of glassware.
  - Aseptic insemination.
  - Isolation of microbe colonies.
  - Microscopic examination of various ferments.
- Synthesis experiments following the study of the analysis of must and wines :
  - Complete analysis of wines brought back from probationary practical work periods or provided by the Director of studies.
  - Application of oenological rules.

- Detection of watering and of addition of alcohol; determining the market value of the wine, its good and bad qualities.
- Drawing up an analytical report.
- Attempts to initiate fermentation in musts under given conditions.

Analysis of by-products:
- Determination of alcohol in lees.
- Determination of total tartaric acid in lees.
- Determination of potassium bitartrate in lees.
- Analysis of oil from the pips.

Study of wine cellars:
- Visits to wine cellars.
- Practical study of the upkeep of wine and use of equipment.

C. EQUIPMENT (16 students).

(1) *Instruments and apparatus.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 16 | Bunsen burners | 14.40 |
| 16 | Tripods | 15.20 |
| 16 | Metal gauzes | 2.40 |
| 24 m | Rubber tubing | 6.96 |
| 20 | Wooden tongs | 3.60 |
| 16 | Metal triangles | 2.40 |
| 1 | Sand bath, sheet metal, gas heated, 25 × 25 cm | 5.40 |
| 2 | Muffle furnaces, gas heated, 17.5 × 14.5 × 8 cm | 34.40 |
| 1 | Drying oven, gas heated, 17.5 × 14.5 × 8 cm | 101.50 |
| 1 | Incubator for bacteriological cultures 60 × 45 × 85 cm | 172.00 |
| 4 | Water baths, constant temp., electrically heated, 30 × 15 × 20 cm | 55.50 |
| 4 | Ebulliometer, Salleron, graduated in $^{1}/_{10}$ | 32.40 |
| 2 | Ebullioscopes, Levesque (20° by $^{1}/_{5}$ of a degree) | 21.00 |
| 1 | Abbé refractometer | 550.00 |
| 2 | Saccharimetric polarimeters with gas burner | 500.00 |
| 1 | Colorimeter, Dubosq type | 71.50 |
| 4 | Mustimeters $^{980}/_{1000}$, with table | 3.60 |
| 4 | Glucometers, Guyot | 2.60 |
| 4 | Extracto-oenometers, $^{1}/_{10}$, and tables | 6.00 |
| 4 | Alcoholometer, from 0°-10°, graduated in $^{1}/_{10}$ | 2.00 |
| 4 | Alcoholometer, from 10°-20°, graduated in $^{1}/_{10}$ | 2.00 |
| 8 | Thermometers, various | 28.00 |
| 1 | Vacuum pump, rotary, oil, $^{1}/_{10}$ mm in 14 min | 172.00 |
| 1 | Balance, to $^{1}/^{11}$ mg | 208.00 |
| 1 set | Weights for above, to $^{1}/_{10}$ mg | 16.00 |
| 2 | Microscopes, obj 10×, 60×, 100×; eyepiece 8×, 15× | 560.00 |
| 2 | Lamps for microscope, 15 W, 110 V | 12.00 |
|  | Total | 2,600.86 |

(2) *Glass and earthenware.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 4 | Stills, P, 250 cc | 49.60 |
| 4 | Stills, P, 1,000 cc | 50.60 |
| 8 sets | Flasks, graduated, 50, 100, 200, 250, 500 and 1,000 cc | 15.76 |
| 4 | Beakers, 250 cc | 2.32 |
| 16 | Mohr burettes, 25 cc, graduated in $^{1}/_{10}$, with stands | 166.40 |
| 16 | Dishes, porcelain, 50 cc | 5.75 |
| 32 | Funnels, 60 and 100 mm diam | 16.64 |
| 32 | Cylinders, graduated, with feet, 100 and 500 cc | 53.60 |
| 20 | Erlenmeyer flasks, 250 cc | 5.80 |
| 100 | Bottles, various capacities | 60.00 |
| 4 | Mortars and pestles, porcelain, 80 and 160 mm diam | 9.70 |
| 12 sets | Pipettes, 1, 2, 5, 10, 20 and 25 cc | 40.32 |
|  | Total | 476.49 |

(3) *Chemicals.*

Acid, hydrochloric
Acid, sulphuric, N
Acid, sulphuric, N/10
Acid, sulphuric, 25 volume%
Acid, tartaric
Alcohol
Fehling's solution
Ferric chloride
Ferric sulphate
Gelatine
Indigo Carmine
Iodine
Litmus solution
Marty's solution
Phenolphtalein solution
Potassium bromide
Potassium permanganate
Potassium thiocyanate
Sodium hydroxide, N
Sodium hydroxide, N/10
Sodium hydroxide, 4%
Starch paste solution

# TECHNOLOGY OF VEGETABLE PRODUCTS OF TROPICAL AND SUB-TROPICAL ORIGIN

A. Course Content (given only as an example to facilitate the use of the inventories).

Definition. General characteristics of extraction and transformation industries concerned with vegetable products from overseas. Regions favourable for the development of such industries. Siting of factories. Industrial buildings.

Factory treatment of paddy. Principle. Equipment. Main stages of treatment. European, Indo-Chinese, and American methods. Flow sheets. Stoved rice. Methods used. Advantages of treatment. Products and by-products of the rice industry. Yields, chemical composition, alimentary and industrial uses. World production and principal producing countries.

Starch extraction. Raw materials, chemical composition and technological characteristics. General principles of extraction and principal stages of treatment. Equipment used. Extracting starch from manioc. Flow sheets. Extracting starch from dry manioc. Starch extraction from maize and rice. Description of the main stages of treatment and of the equipment used. Flow sheets. Products and by-products of the starch extracting industry. Yields. Norms. Alimentary and industrial uses. World production and principal producing countries.

Industries for the transformation of starch. Basic facts about depolymerization and hydrolysis of starch. Manufacture of tapioca and dextrins. Glucose industry: manufacture of glucose syrups; hydrated glucose and anhydrous dextroses. Flow sheets. Manufacture of seasonings and soluble starches, dextrins and glucoses. World production and principal producing countries.

Cane sugar industry. Raw material. Chemical composition and technological considerations. Elements of manufacturing control. Principles of sugar manufacture and main stages of treatment. Handling. Extraction of cane juice. Description of cane mills. Purification of cane juice. Evaporation. Cooking. Crystallization. Centrifuging. Drying. Yields. Chemical composition and utilization of by-products of the cane sugar industry. Brief account of sugar refining. Classical methods and methanol treatment.

Production of industrial alcohol. Raw materials. Description of the main stages of manufacture and of the equipment used. Preparation of "worts": saccharification by malt and physico-chemical saccharification. Fermentation or preparation of "wines". Distillation and rectification. "Amylo" method. Manufacture of absolute alcohol. Utilization of distillery by-products. Industrial uses of alcohol. World production and principal producing countries.

Rum manufacture. Generalities. "Agricultural" and "industrial" rums. Chemical characteristics. Coefficient of impurities. Description of the principal stages of manufacture and of the equipment used. Composition. Fermentation. Distillation. Ageing of rums. World production and principal producing countries.

Fat industries. Chemical constitution, physical properties, and classification of fats.

Oil factories. Preliminary operations: cleansing, decortication, crushing, heating. Extraction processes: fermentation, pressing; action of solvents; electrolysis. Description of the equipment used. Purification of fats in the oil factory: demucilagination, drying, filtration. Equipment used.

Fat refining. Objects of treatment. Essential stages: neutralization, decoloration or bleaching, deodorization, demargarination, filtration on paper. Equipment used. Vat processes and continuous processes. Flow sheets. Hydrogenation of fats. Manufacture of vegetable butters. Manufacture of margarine. Classical and continuous processes ("Voltator"). Flow sheets.

Technology of products of secretion. Essential oils industry. Raw materials. Extraction methods: pressing, steam distillation, action of solvents, scenting. World production and principal producing countries.

Factory working of Revea latex. Chemical composition of Revea latex. Principal stages of treatment: collecting; transportation to the factory; filtration; dilution; coagulation; dewatering by rolling, smoking-drying. Concentrated latex: jatex and revertex. Other sources of natural rubber.

Chocolate making. Raw materials. Chemical composition and technological characteristics. Principal stages in the manufacture of chocolate; cleansing, weighing, roasting, crushing, milling, blending, homogenization of the mixture; refining the paste; moulding; cooling; unmoulding; wrapping. Equipment used. Manufacture of "solubilized" cocoa powder, and cocoa butter. World production and principal producing countries. Composition of the various products of the chocolate industry.

Preserving. Generalities. Brief overall sketch of the preserving industries. Short description of the various methods of preserving tropical and subtropical foodstuffs. Drying, dehydration. Preservation by cold. Refrigeration industries. Quick-freeze. Compound refrigeration. Preservation by heat processing. Flash-pasteurization, canning or appertization. Preserving methods of secondary importance.

B. Practical Work.

(1) Visits to factories treating or transforming vegetable products of tropical and subtropical origin (oil, margarine, glucose factories, rubber manufacturing works, distilleries, chocolate factories, etc.).

(2) Annual study journey in the course of which students visit rice plantations, rice factories, plantations of perfumery plants, perfume distilleries, oil and soap factories, centres of agronomical research, botanical gardens, etc.

## DRAWING AND TOPOGRAPHY

A. Course Content and Practical Work (given as an example to facilitate the use of the inventories).

(a) Drawing. Its interest in relation to agricultural machinery. Methods: representation of bodies in space. Diagrams and graphs. Scales and dimensions. Conventional colouring. Reading an industrial drawing. The drawing of machined, forged, moulded, and soldered parts, of parts made of metal sheet of gears. Standardization in building. Architectural drawings. Methods of execution.

Dimensions. Representation of shapes. Scales and diagrams. History of architecture. The different orders. Tracing shadows. Problems it raises. Graphical statics. Centres of gravity. Moments of inertia. Balance and buildings. Topography. Map scales. Measuring instruments. Calculation of errors in topographical operations. Planimetry. Taking of levels. Photography.

(b) Study in small groups of a piece in the rough and of the operations by which it becomes a finished piece. Study of the machine tools necessary in manufacture; drawings of some of them.

B. Equipment (25 students).

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 colln | Blueprints of machine parts | — |
| 2 | Blackboard compasses, 50 cm | 5.00 |
| 25 boxes | Compasses | 700.00 |
| 10 pkts | Coloured chalks | 2.50 |
| 1 colln | Architectural drawings | — |
| 25 | Set-squares, 60° | 22.50 |
| 25 | Set-squares, 45° | 22.50 |
| 1 colln | Various models of machine parts | — |
| 1 | Pantograph, complete with accessories, in box, 60 cm | 81.20 |
| 25 | Drawing boards, 78 × 58 cm | 182.00 |
| 5 | Planimeters | 140.00 |
| 25 | Slide rules, 25 cm | 148.50 |
| 1 | Slide rule, for demonstration, 1.50 m | 8.50 |
| 1 | Carpenter's ruler, 2 m | 1.00 |
| 2 | Parallel rulers, for the blackboard | 10.50 |
| 25 | Flat rulers, 50 cm | 70.00 |
| 10 | Drawing boards, adjustable slope, 105 × 80 cm | 343.00 |
| 25 | T squares, movable head, 90 cm | 122.50 |
|  | Total | 1,859.70 |

## FOURTH PART

# PLANT AND ANIMAL PRODUCTIONS

# AGRICULTURE

## (temperate regions)

A. COURSE CONTENT (given only as an example to facilitate the use of the inventories).

*General agriculture.*

I. Factors of production.
  (1) The environment.
    (a) The climate: temperature, light, water, wind, atmospheric electricity, combined action of climatic factors.
    (b) The soil: static study; dynamic study; the sub-soil, fertility; study of the main types of agricultural soils; estimation of the agricultural value of soils; soil classification.
  (2) The plant.
  Seeds; germination; vegetative growth; plant nutrition.
II. Cultivation.
  (1) Physical improvement of the soil.
    (a) Working the soil: clearing, removing stones, tilling, quasi-tilling, harrowing, rolling, combination of these various operations in accordance with the end desired.
    (b) Soil amendments: definitions, roles, lime or organic amendments.
  (2) Technique of applying fertilizers.
  Need for complementary fertilizers. Mobilization of reserves in the soil. Cultivation without fertilizers. General conditions of use. Amount. Kind of fertilizers (nitrogenous, phosphate, potassium); other elements (plastic and catalytic elements).
  (3) Seasonal work.
  Sowing and planting. Surface treatments: harrowing, hoeing, ridging; objects, methods, conditions under which they are used. Destruction of weeds.
  (4) Shift and rotation of crops.
  Definitions; history. Rotation: need, different theories; characteristics of a good rotation. Shift: factors governing choice: relation between shift and rotation of crops; relation to the system of cultivation; different types of rotation, examples, criticism, conditions in which they are used.

*Special agriculture.*

Study of the different cultivated plants will be undertaken according to the following general plan: historical and economic study, botanical and biological study, cultivation, harvesting and storage of products, analysis of the crop, general problems of improvement of cultivation and of the plant.

I. Main crop food plants.
  (1) Cereals: common wheat, hard and duckbill wheats; rye, maslin; barley; oats; buckwheat; maize; millet; Hungarian millet; sorghum.
  (2) Leguminous plants with seeds: peans; beans (*Phaseolus vulgaris*); lentils; beans (*Vicia faba*); horsebeans; soya beans.
  (3) Storage of grains: biology of grains during storage; accidents and enemies. Principles and methods of storage.
  (4) The potato.
II. Industrial plants.
  (1) Sugar beet: normal study. Production of seed; distribution of zones of culture; "planchon" method, American method.
  (2) Textile plants: flax, hemp, genista.
  (3) Oil plants: winter and spring colza; winter and spring rape; white mustard; black mustards; oil poppy; sunflower; safflower.
  (4) Aromatic plants: tobacco, hops, chicory for coffee.

III. Fodder plants.

(1) Annuals.

Plants that need weeding: beetroot; carrot; turnip; swede; parsnip; Jerusalem artichoke; cow cabbage, pumpkins. Plants that do not need weeding: fodder grains; maize; Hungarian millet; sorghum; red clover; vetches; vetchling; horsebean; grey peas; small lentils; soya; fenugreek; lupin; furze; Alexandria clover; serradilla; colza; rape; mustard; pimpernel; spurry; sunflower; Jerusalem artichoke.

Fodder mixtures: problem of the fodder plot; all the year round supply of green fodder.

(2) Pluriannual cultures.

Plants cultivated alone: lucerne (alfafa); common clover; black medic; sainfoin; bird's foot trefoil, melilot. Complex mixtures: biology of meadow species: temporary meadows; permanent meadows.

(3) Harvesting and storage of fodder crops.

Season and methods of cutting. Dry storage. Silage of green fodder.

### B. PRACTICAL WORK.

I. Study of applied systematics.

(1) Study of the seeds of plants cultivated in temperate regions: dissection of typical examples of the main categories of seeds (bare seed without albumin, partially bare seed, simple bare fruit, simple covered fruit, compound fruit); morphological study of the seeds of Gramineae, Leguminosae, Cruciferae, and other families of importance to agriculture.

(2) Morphological study of the main cultivated plants.

(3) Analysis of seed samples and germination test techniques.

(4) Pre-sowing treatment of seeds.

(5) Study of the main species of one genus; e.g. *Triticum*, *Avena*, *Hordeum*, *Brassica*.

(6) Basis of definition of the varieties of the main plants cultivated in temperate lands.

(7) Estimation of a meadow flora.

(8) Study of the seeds of the commoner weeds.

(9) Study of the main weeds at different stages of their growth.

II. Study of amendments and fertilizers.

Recognition. Properties. Behaviour in the soil and conditions of use.

Liming: limes, marls, chalks, shell marls, defecation scum.

Nitrogenous fertilizers:

nitrate: sodium and calcium nitrates; ammoniacal and assimilated: ammonium chloride, crude ammonia, urea, cyanamides, ammoniacal liquors; ammoniaco-nitric: ammonium nitrate; organic: oil cake, meat, blood, horn, wool waste (shoddy).

Phosphate fertilizers: mono-, di-, tri-calcium phosphates; superphosphates, vinasse.

Compound and complete fertilizers.

Mixture of fertilizers. Storage.

Fertilizer trade.

Determination of the formula of fertilizers.

III. Estimation of the agricultural value of a soil. Taking of soil samples.

IV. Bases of the appraisal of crops at different stages of growth.

V. Practical cultivation work.

Introduction to the school's farms: visits to the fields and buildings; study of the means of production.

Critical study of the cultivation plan and of the fertilizer plan: review of the productive factors, succession and rotation, fertilizer plan.

Introduction to the general running of farms: visits to fields under cultivation with various crops, advance planning of necessary work, organization of workshops, estimation of the quality of work done.

Farm inventories: drawing up of rough balance sheets. Annual inventories; introduction to practical valuation of standing crops at various seasons of the year.

Preparation of the soil: working the soil, opportunity, organization, execution, results; use of lime and organic amendments and fertilizers; preparation, transport, spreading, burying.

Preparation of seeds, sowing, planting: cleansing, weighing, treating of seeds against cryptogamous diseases; preparation of seed potatoes; determination of the quantity of seed necessary; carrying out sowing and planting; organization of workshops.

Estimation of crops; maintenance: examination of the density of population after germination; leaf mould; destruction of weeds; visits to crops at different stages of growth; fight against the crops' enemies.

Harvesting and storage of products: signs of maturity, season of harvest, estimation of yield by simple probing and by geometric weighing, different methods for mowing and haymaking; gathering and storage of beets, potatoes, grain crops; ensilage of green fodder and cooked potatoes; judging the quality of products at the time of harvest and during storage.

C. EQUIPMENT (group of 20 students) (see also course in Agricultural Machinery).

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 colln | Seeds of the main cultivated plants | — |
| 1 colln | Seeds of the main weeds | — |
| 1 colln | Wall pictures showing morphological characteristics of cultivated plants | 27.50 |
| 1 colln | Wall pictures showing different types of rotations | 20.00 |
| 1 colln | Samples of fertilizers | 4.50 |
| 1 colln | Samples of amendments | 4.50 |
| 1 | Apparatus for measuring the pH of the soil by La Motte's method | 10.00 |
| 1 | Apparatus for determining the amount of nitrates in the soil by La Motte's method | 10.00 |
| 1 | Apparatus for determining the amount of available phosphorus in the soil by La Motte's method | 12.50 |
| 20 | Magnifying glasses on stands | 29.00 |
| 200 | Watch glasses, 10 cm diam | 17.00 |
| | Total | 135.00 |

# AGRICULTURE

## (tropical regions)

COURSE CONTENT (given only as an example to facilitate the use of the inventories).

*General agriculture.*

I. The environment.

(1) Climate.

Climatic factors: definition of climate. Natural and artificial microclimates. Meteorological and other factors. Solar radiation; clearness and nebulosity. Heat and temperature. Atmospheric pressure, winds. Moisture in the atmosphere. Atmospheric electricity. Climograms. Tropical climates: their characteristics. Sub-climates. Climatic factors and agricultural practice.

(2) Soil and elements of pedology.

Factors in soil formation: definition of soil. History. Life of the soil. Pedology. Edaphic complex. Factors of formation. Parent rock: constituent elements. Ignaceous, sedmentary, metamorphic rocks. Brief geological review of the tropics. Geological formations and the fertility of the land. Climate: basic ideas (Electrolysis; pH, colloides dispersed systems). Internal and external climate. Zonal and azonal soils. Physical and chemical actions of climate. Disintegration of rocks and transportation of the products. Horizons and profile of a soil. Podsols. Chernozem soils. Brown and chestnut coloured soils. Laterite and various lateritic soils. Other factors of formation: vegetation and various living organisms. Relief. Weather. Man.

(3) Living creatures.
Biotic factors of the atmosphere and soil: the biotic complex. Biotic factors of the atmosphere: vegetation, botanical zones in the tropics; unfavourable factors (weeds), favourable factors (green manure); animal and plant parasites. Heavy toll taken of tropical agriculture by parasites. Biotic factors of the soil: roots of plants; micro-organisms: plant (Bacteria, Fungi, Algae), animal (Protozoa, Worms, Molluscs, Mammals).

(4) Properties of soils.
Physical, chemical and biological properties. Dynamism of the natural environment.

(5) The human environment.
Demography and agricultural labour supply.
Social organization and system of land tenure.
Economic equipment and industrialization.
Professional agricultural organization.

II. Plant and animal in tropical agricultural production.

(1) The plant.
Plant nutrition. Actions of factors in the natural environment and internal actions. Improvement of cultivated plants.

(2) The animal.
Improvement of stock. Improvement of fodder production. Pastoral hydraulics.

III. Action of man on the soil.
Primitive systems of cultivation.
Soil impoverishment.
Improved primitive systems.
Modernized systems of cultivation: stages in modernization; fight against soil impoverishment. Fight against parasites. Mechanization (dangers to be avoided). Industrialization of the treatment of crops.
Cover plants, green manures, shade trees: role, desirable qualities; methods of use; principal Leguminosae employed.
Amendments: their role. Siliceous, clay (crushed rock), calcareaous, humic, amendments. Humus, its deficiency in tropical soils; humus amendment and organic manure. Sources of humus. Farmyard manure, artificial manure, mixed manure, composts, their preparation. Folding of animals.
Chemical fertilizers: rules for their use, criticism. Special action of nitrogen, phosphoric acid, potash, lime. Nitrogenous, phosphatic, potassic, fertilizers and their use in the tropics. Trace elements. Compound fertilizers. Necessity for balanced application of organic and chemical fertilizers. Economic conditions for the use of amendments and fertilizers.

*Special agriculture.*

I. Fodder cultivation in the tropics.

(1) Natural pasturage.
General aspect as a function of climate, soil and flora; composition of the flora. Deficiency in mineral substances, capacity for supporting livestock, utilization and improvement of pastures.

(2) Artificial pasture.
Conditions of establishment. Soil: preparation, manuring, planting and upkeep.

(3) Tropical fodder plants.
General: multiplication—upkeep.

Perennial grasses: *Pennisetym*, *Panicum*, *Paspalum*, *Andropogon*, *Melinis*, *Tricholaena*, *Chloris*, *Saccharum*, *Ischaemum*, etc.
Annual grasses: Maydeae, *Sorghum*, *Eleusine*, etc.
Perennial Leguminosae: Lucerne (alfafa), clovers, *Pueraria*, *Indigofera*, etc.
Annual Leguminosae: *Soja*, *Mucuna*, *Vigna*, *Dolichos*, *Phaseolus*, *Canavalia*, *Lespedeza*, etc.
Leguminosae shrubs: *Cajanus*, *Leucoena*, etc.
Tuberous plants: sweet potato, manioc, yams, etc.
Miscellaneous plants: Sunflower, *Polygonum*, *Cucurbitaceae*.
Drought-resisting plants: *Pountia*, *Atriplex*.

(4) Fodder reserves.
Ensilage: pit silos, tower silos, silage in stacks.
Hay production: hay dried by the air and by artificial means.
Storage of tubers, chip drying.
Fodder from germinated grains.

(5) Animal feeding.
Ration tables for the main species of tropical animals.
Nutritive value of the different categories of tropical feeding stuffs.

II. Cultivation and preparation of tea.
History.
Distribution according to type of tea plant.
Geographical distribution.
Economy, production and consumption.
Botany.
Cultivation: climate, soil, land clearance and arrangement, seed beds, nurseries, plantation, upkeep, green manures, shading, fertilizers, pruning, picking.
Insects and diseases.
Selection.
Chemistry.
Preparation: black tea, European preparation, transport of the crop to the factory, bruising, rolling, fermentation, crying, sorting, packing. Black tea: Asiatic preparation. Green tea.
Quality of the product: valuation, blending, influence of water, consumption of tea.
Substitutes.

III. The oil palm.

(1) Botany of *Elaeis guineensis*, *Jacq*.
Systematic position of the species, classification. Origin of *Elaeis guineensis*. Area of distribution. So-called natural populations. Varieties and their classification. Morphological description of *Elaeis guineensis*. Root system. Trunk. Leaf. Male spadix. Female spadix. Fruit system. Fruit. Seed and structure of the kernel. Vegetative cycle of the oil palm.

(2) Selection of the oil palm.
The conception of species and variety applied to the *Elaeis guineensis*.
Classification according to the thickness of the shell of the fruit.
State of knowledge concerning the genetics of some important characteristics: thickness of shell (*Dura*, *Tenera*, and *Pisifera*). Accretion of supplementary carpels. Pigmentation of the fruit. Insertion of leaflets and *idolatrica* type. Other characteristics.
Practice of selection. Search for parent trees: productivity and criterium of good productivity. Study of main characteristics of interest to selection for system, fruit, kernel, stem, leaf, root system.
What variety should be selected? Role and importance of *Dura*, *Tenera*, and *Pisifera*.
Practical succession of selection operations starting from trees under observation. Analysis of systems. Analysis of fruits. Recording of vegetative characteristics.
Technique of artificial fertilization.
Preparation of a selected first generation at the research station.
Observation of first generations and organization of comparative tests of their descendants.

(3) Oil palm plantations.

Needs of the oil palm. Native exploitation of the oil palm. Choice of material for planting. Germination of oil palm seeds: practical methods. Setting up the nursery; preparation of ground and organization. Organization of the plantation, division into sections, creation of roads, siting of factory.

Planting: staking, preparing holes, putting the palm trees in position.

Upkeep of plantations on burnt and unburnt forest clearings. Covering and Forestry system. Production by the oil palm: coming into production, method of gathering. Manuring palm plantations.

IV. Oil bearing plants other than the oil palm.

(1) Ground-nut (*Arachis hypogea*).

The plant and its varieties.

Botanical description of *Arachis hypogea*. Species and sub-species: classification (Loureiro, Dubard, Chevalier, Bouffil). Varieties: their classification into five groups (by A. Chevalier). Geographical distribution of varieties. Selection (Mr. Bambey's station). Biology: Germination. Root system. Growth and nutrition of the plant. Flowering and fruit bearing. Duration of vegetation.

Area of cultivation. Ecological conditions.

Culture in various countries.

Tropical Africa: primitive methods. United States: animal and machine cultivation. Work and cultivation. Manures. The ground-nut and soil impoverishment. Yields.

Products and by-products.

Pods and seeds: their composition. Utilization. Peanut oil and butter. Peanuts for food and confectionery. Oil cakes. Fodder.

Development of production.

Improvement of traditional method of cultivation. Mechanization of cultivation. Problems raised; solutions proposed.

(2) Coco-nut Palm (*Cocos nucifera*).

Botanical description. Varieties.

Appearance of the coco-nut palm. Root system. Leaves. Inflorescences and pollination. Fruits. Characteristics of varieties. Dwarf coco-nut trees.

Area and conditions of growth.

Origin. World distribution of coconut groves. Climate. Soil.

Culture.

Preparation of plants: choice of variety, choice of coconuts as seed, seed beds, nurseries. Preparation of soil and planting: clearing bush, staking and preparing holes, method of transplantation. Maintenance work: replacements, cleaning, watering, intercropping, manuring.

Products.

Fruit bearing. Gathering. Yields. Various uses: of roots, of trunk, of leaves, and of terminal shoot, of inflorescence, and of fruits. Copra.

(3) Castor oil (*Ricinus communis*). Plant.

The plant and its varieties.

Botanical review. Seeds. Species and varieties: Dubard and Eberhardt's classifications. Other classifications. Selection.

Area and conditions of growth.

Origin. Principal producing countries. Climate and soil.

Culture.

Cultivation in winter and in the dry season. Yields.

Products.

Various uses: seeds, oil. Oil cakes.

(4) Physic nut (*Jatropha curcas*).

The plant and its varieties. Ecology and culture. Products.

(5) Aleurites (Aleurites spp.).

China wood oil and wood oil. Species of aleurites. Their common characteristics. Their distinctive characteristics. Ecology and culture of *Aleurites Fordii* and *Aleurites montana*. Plantations in various countries. Yields. Treatment of the nuts. Production. Native method. Modern industrial method. Principal producing countries: of toung oil, of abrasin oil, consumption.

(6) Siccative oils.

(7) Shea-butter nut (*Butyrospermum parkii*).
Botanical description; fructification; the fruit and its kernel, its fat content; varieties. Ecology: climate and soil. Its natural populations; possibility of cultivation; yields. Production: native and industrial methods of extracting the oil; characteristics of the oil; trade; production plan.

(8) Sesame (*Sesamum indicum*).
Botanical description and varieties. Ecology. Production.

V. The Coffee tree (*Coffea* spp.).
Historical. Botanical. Floral biology. Physiology. Classification of the coffee tree species. Cultivated species and varieties. Breeding. Setting up and maintenance of estates. Gathering. Preparation of saleable coffee. Coffee trade. Production and consumption in the world. Genetic breeding. Diseases and insects.

VI. The Cacao tree (Theobroma cacao).
Historical. Botanical and systematic. Ecology. Growth and development. Ramal and floral biology. Cultivated species and varieties. Nurseries. Establishment and maintenance of plantations. Cover crops and shade given by trees. Gathering and fermentation of beans. Production and consumption. Diseases and insects.

VII. The Cinchona tree (*Cinchona* spp.).
Historical. Botanical and systematic study of species. Ecology. Germination and breeding. Plantation and maintenance of trees. Forestry method of exploitation and others. Technique of selection. Stripping and preparation of barks. Centres of production. Physiological action of quinine and other alkaloids extracted from the barks of Cinchona trees. Synthetic antimalarial drugs. Diseases and insects.

VIII. The Vanilla plant (*Vanilla planifolia*).
Historical. Botanical and systematic. Cultivated species. Centres of production and their techniques. Propagation by cuttings. Conditions for germination of seeds. Floral biology. Hybridization. Establishment and maintenance of Vanilla plantations. Supporting and shading of lianae. Superimposed and artificial pollenization of flowers. Picking and preparation. Insects and diseases of the living plant and the commercial product. Presenting production on market. Conditioning of and trade in Vanilla.

# TECHNIQUE OF PLANTATIONS AND THEIR EFFECTS ON THE SOILS OF TROPICAL REGIONS

COURSE CONTENT (given only as an example to facilitate the use of the inventories).

(1) Prospecting the area to be planted.
Study of the climate.
Study of soil and vegetation.
Examination of communications.
Examination of questions of labour supply.

(2) Land clearance.
(a) Influence of climates on the soil; temperate and equatorial climates.
(b) Evolution of organic matter in tropical soils; factors in its transformation: temperature, microbial activity, C/N ratio in organic matter, lignin content of organic matter.

(c) Effects of clearance on forest soils: the forest is a plant formation at its climax. Destruction of organic matter by biological, chemical and photochemical oxidation. Organic matter lost by clearing and denudation. Importance of plant cover as a protection. Indispensability of restoring a cover after clearance. Inevitable diminution of fertility due to losses of humus, nitrogen and exchangeable bases, and to transformation of phosphates. Methods of reducing these losses.

(3) Establishment of plantations.

(a) Methods of preparing the ground: by cutting down the forest followed by burning, by clearing the forest followed by removal of cut vegetation without burning.

(b) Precautions to be taken against erosion when planting ground on a slope: very slight slope, steep slopes, hillsides.

(c) Technical and practical details of the operations for soil conservation: Preparations for felling a forest; successive cutting of undergrowth and timber; drainage where necessary; cutting, drying, burning; staking out on flat or undulating ground, and on hills following contour lines; preparing planting holes.

# VITICULTURE

A. Course Content (given only as an example to facilitate the use of the inventories).

(1) Ampelology.
Systematics. The genus *Vitis*. Species. Vine plants. Reproduction. Hybridity. Vegetative reproduction. Propagation by cuttings, by runners, layering, grafting. Production of new plants. Nurseries. Vineyards. Plantations.

(2) General viticulture.
Vegetative equilibrium. Climate, soil, density and arrangement of plantations, parent stocks. Choice of vine plant. Pruning. Staking. Tillage. Manures. Irrigation. Trimming. Leaf thinning. Annular incision.

(3) Vine pathology.
Accidents and diseases of non-parasitic origin: frosts, scorching, lightning, hail winds. Chlorosis. Salinity of the ground. Drought. Bleeding. "Rougeot" (reddening of leaves). "Brunissure" (browning of leaves). Blights. Diseases caused by filtrable viruses. Bacterial diseases. Cryptogamic diseases. Phanerogamous parasites.

(4) Miscellaneous.
Wine production throughout the world. Production of fresh grapes. Production of spirits. Other productions. Economics. Professional, administrative organization. Marketing.

B. Practical Work.

Morphology and ampelography. Floral morphology and hybridization. Taking cuttings, grafting. Nursery work. Plantations.
Pruning and maintenance work in the vineyard.
Vine pathology, macroscopic and microscopic study of diseases and accidents.
Geography of viticulture.

C. Equipment (for 40 students).

(1) *Living material.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 | Ampelographic collection of 12.5 acres | — |

(2) *Instruments and material for practical work.*

| | | |
|---|---|---|
| 1 | Projector for slides, lamp 250 W, 110 V | 178.00 |
| 4 t | Wood for grafting | — |
| 40 | Spades | 90.00 |
| 12 | Wall pictures | 12.00 |
| 40 | Two handed " vinegrowers " scissors, 45 cm | 88.00 |
| 1 | Water cistern | — |
| 1 | Line, 4 mm diam, 20 m long, with 2 wooden pegs | .80 |
| 1 colln | Samples | — |
| 5,000 | Wooden labels for trees, 85 × 18 mm | 23.00 |
| 30 kg | Wire | 7.00 |
| 40 | Grafting knives | 14.00 |
| 40 | Hoes, 14 cm wide | 44.00 |
| 1 | Herbarium | — |
| 40 | Binocular microscopes | 6,440.00 |
| 5 | Grafting machines, for cutting the scion, 2.7 kg | 54.30 |
| 1 | Grindstone | 10.00 |
| 40 | Microscopes, eyepiece 10×, obj 10×, 43× | 6,700.00 |
| 1 | Injecting stake | 15.00 |
| 1 pr | Castrating forceps, 20 cm long | 2.00 |
| 20 pr | Cutting forceps, 20 cm long | 45.20 |
| 5 | Knapsack sprays, with pressure gauge, 8 l | 76.50 |
| 40 | Protractors and decimeter rulers | 9.85 |
| 1 | Machine for tracing furrows, width of blades 20 cm | 1.50 |
| 480 | Small scale pictures | — |
| 200 | Pollination bags, 20 × 31 cm | 1.75 |
| 1 | Hot chamber for stratification of cuttings for graftings | — |
| 40 | Secateurs | 22.80 |
| 50 | Wall pictures and diagrams | 50.00 |
| 40 | Micrography kits | 306.35 |
| | Total | 14,192.05 |

(3) *Produits chimiques.*

Lime
Sulphur
Copper sulphate

# INTRODUCTION TO HORTICULTURE

A. Course Content (given only as an example to facilitate the use of the inventories).

(1) Introduction. Historical development of orcharding.
(2) Horticultural botany.
Systematic horticulture, nomenclature, varieties.
Morphological aspects of the fruit plant, especially vegetative structures.
Morphology of fruits and flowers.

(3) Factors which influence rate of growth of trees.
  Essential elements.
  Water.
  Phytohormones.
  Relationship between carbonhydrates, nitrogen and growth.
(4) Climate.
  Adaptation of plant to environment.
  Limiting factors: cold, heat.
  Modification of environmental factors by man.
  Rest period, photoperiod.
(5) Propagation.
  Seedings vs. grafted or budded plants.
  Evaluation of methods.
  Rootstock.
(6) Orchard variation.
  Environmental factors.
  Bud sport or chimeras.
  Rootstock effects.
(7) Fruit buds and their formation.
  Kinds of buds.
  Nature, time and factors in fruit bud formation.
(8) Fruitfulness in trees.
  Factors of pollination, cropping, alternate bearing, etc.
(9) Pruning as applied to various fruit crops.
  Orchard soil management.
(10) Seasonal changes and ripening process in fruits.

B. Equipment.

*Demonstration apparatus.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 colln | Slides (morphology of fruits and flowers, soil management, etc.) | 50.00 |
| 1 colln | Wall charts | 50.00 |
| | Total | 100.00 |

## SYSTEMATIC POMOLOGY

A. Course Content (given only as an example to facilitate the use of the inventories).

(1) Historical aspects of systematic pomology.
(2) Types of classification.
  (a) Botanical based on natural affinities.
  (b) Horticultural based on useful characters or qualities.
(3) Survey of plant kingdom with particular emphasis on 32 families which provide the fruit trees of economic importance. Each family is considered according to the following outline:
  (a) Botanical nomenclature and relationships.
    Floral characteristics.
    Synonyms.

(b) Horticultural relationships.
Economic importance.
Horticultural varieties. Description of varieties.
(c) Morphology of plant.
Factors important in propagation of particular plant.
(d) Morphology of flower and fruit.
Botanical fruit.
Horticultural fruit.
(e) Pollination requirements and related phenomena.
(f) Classification and identification.
Use of botanical and horticultural keys.
Identification of plate displays or unknown specimen.

The following families are considered in detail:

Moraceae
Rosaceae (Pomae, Pruneae, Rubeae)
Vitaceae
Lauraceae
Punicaceae
Myrtaceae
Lecythidaceae
Palmaceae
Rutaceae
Anacardiaceae
Sapindaceae
Bromeliaceae
Annonaceae
Ebenaceae
Sapotaceae
Betulaceae
Fagaceae
Proteaceae
Juglandaceae
Passifloraceae
Caricaceae
Flacourtiaceae
Cutiferaceae
Musaceae
Cactaceae
Rhamnaceae

B. LABORATORY WORK.

Dissection of fresh plant material or preserved specimens.

C. EQUIPMENT.

(1) *Demonstration apparatus.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 200 | Diapositives (black and white and coloured) | 120.00 |
| 25 | Wall charts | 25.00 |
| | Total | 145.00 |

(2) *Laboratory apparatus* (15 students).

| | | |
|---|---|---|
| 20 | Forms on horticultural classification and names of specific fruit groups | — |
| 15 | Fruit description blanks | — |
| 15 | Microscopes, eyepiece 10×, obj 10×, 43× | 2,512.50 |
| 15 | Microscope lamps, 15 W, 110 V | 60.00 |
| 1,000 | Microscope slides | 15.70 |
| 15 g | Microscope cover slips | 1.75 |
| 15 | Dissecting needles, straight | .65 |
| 15 | Dissecting needles, bent | 1.08 |
| 15 | Dissecting needles, spear point | 2.05 |
| 15 | Scalpels, 38 mm edge | 11.25 |
| 5 | Bunsen burners | 5.75 |
| 5 m | Rubber tubing | 3.00 |
| | Total | 2,613.73 |

(3) *Fresh and preserved materials.*

Fresh materials of available fruit varieties.
Fresh plant material and preserved specimens employed for morphological study.
Dried and canned fruits.

# CITRICULTURE

A. COURSE CONTENT (given only as an example to facilitate the use of the inventories).

(1) Botanical relationship of the important commercial citrus fruits.
  (a) Nomenclature.
  (b) Botanical characteristics of the species.
(2) Citrus fruit varieties.
  (a) Description of plant and fruit of the important varieties.
  (b) Identification and classification of the fruits.
    Botanical classification.
    Horticultural classification.
(3) Climatic requirements and tolerances of the citrus fruits.
  (a) Heat and cold tolerances.
  (b) Effect of climate on quality, marketability and season of maturity.
  (c) Modification of environment by man.
    Orchard heating.
    Windbreaks.
    Irrigation.
(4) Orchard management practices and problems.
  (a) Tillage practices.
  (b) Fertilization application and requirements.
  (c) Irrigation practices and methods.
  (d) Tree management
    Pruning. Spraying.
(5) Development of orchard.
  (a) Choice of kind of citrus fruit and variety in relation to climatic condition.
  (b) Rootstock effects.
  (c) Selection of rootstock seedlings (nucellar seedlings).
  (d) Development and care of nursery trees.
  (e) Setting out the orchard, spacing, care of trees, interplanting.
(6) Utilization of the crop.
    Products and by-products.
(7) Economic outlook for the various citrus fruits.
  (a) Local situation.
  (b) In the world.
(8) History of citriculture.
  (a) Development of marketing co-operatives.
  (b) Development of new products and by-products.

B. LABORATORY WORK AND FIELD TRIPS.

Laboratory exercises or field work in the university orchards are given weekly.

Four all-day field trips are made to citrus growing areas to observe and study problems in the field. Such trips include stops at nurseries, packing houses, orchards and by-products plants.

C. EQUIPMENT.

(1) *Demonstration apparatus.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 6 | Wall charts | 6.00 |

(2) *Laboratory apparatus* (group of 6 students).

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 6 | Beakers, P, 250 cc | 1.14 |
| 6 | Cylinders, graduated, 250 cc | 9.00 |
| 6 | Funnels, 150 mm diam | 5.10 |
| 6 | Hydrometers | 6.00 |
| 6 | Reamers, fruit juice | 6.00 |
| 6 | Thermometers, —10 to 110° C | 9.00 |
| | Tables and charts of Brix figures (giving percentage of sugars, expressed in equivalent amount of saccharose, as a function of density) | — |
| | Total | 36.24 |

(3) *Fresh material.*

Fruit samples consisting of plate displays and single fruits for each student to cut and taste.

# SUBTROPICAL FRUITS OTHER THAN CITRUS

A. Course Content (given as an example to facilitate the use of the inventories).

The following fruits, considered as of major importance in subtropical areas, are studied in detail: almond, avocado, date, fig, olive, pecan, persimmon and walnut.

Fruits of minor economic importance are given brief consideration. Among these are cherimoya, macadamia, white sapote, carissa, loquat, guava, mango, litchi, passion fruit, pomegranate, papaya, banana.

Each fruit is considered according to the following outline.

(1) Botanical studies.
  (a) Nomenclature.
  (b) Morphology of plant and fruit.
(2) Climatic requirements and tolerances.
  (a) Adaptation of varieties to extreme conditions.
  (b) Modification of environment to allow commercial production.
    Orchard heating.
    Windbreaks.
    Irrigation.
(3) Pollination problems.
    Provision of pollinators (if necessary).
(4) Propagation.
  (a) Choice of variety.
    Economic aspects.
    Horticultural aspects.
  (b) Choice of rootstock.
  (c) Nursery practices.
(5) Development of orchard.
  (a) Site, exposure.
  (b) Spacing.
  (c) Planting and care of young orchard.
(6) Orchard management programme.
  (a) Fertilization requirements.
  (b) Irrigation practices.
  (c) Pest and disease control.
  (d) Tree maintenance, pruning.

- (7) Fruit harvesting.
  - (a) Fruit maturity standards.
  - (b) Special handling problems.
  - (c) Storage problems.
  - (d) Products and by-products.
- (8) Economics of the industry.
  - (a) Stability of the industry.
  - (b) Marketing problems.
  - (c) Competitive products.
  - (d) Future of the industry.

### B. Laboratory Work.

Description and identification of varieties of subtropical fruits other than citrus (for the latter see " Citriculture ").

### C. Field Trips.

Visits to large orchards or groves and discussion of field problems with the grower or government farm advisor in the field. Visits to packing houses, water supplies (dams), and experiment stations. Field demonstrations of rootstocks, bud selection, varieties, etc., are given by instructor.

### D. Equipment.

Most of the exercises use the collection of species and varieties found in the orchard attached to the school. Unusual varieties which are not available locally may be purchased.

Also used for the demonstrations and exercises are:

| | |
|---|---|
| 1 colln | Coloured projection slides. |
| 1 colln | Preserved materials. |
| 1 colln | Mimeographed exercises outlines. |

## FRUIT PHYSIOLOGY AND STORAGE PROBLEMS

A. Course Content (given only as an example to facilitate the use of the inventories).

- (1) Fruit respiration.
  - (a) Basic concepts. Aerobic and anaerobic process. Methods of measurement.
  - (b) The nature of the climacteric rise and factors affecting it.
    - Temperature.
    - Oxygen.
    - Carbon dioxide.
    - Ethylene and plant emanations.
  - (c) Chemical changes during development and ripening.
    - Enzymatic activities.
- (2) Fruit handling.
  - (a) Field practices.
  - (b) Maturity standards.
  - (c) Packing house practices.

(3) Fruit storage.
    (a) Transpiration losses.
    (b) Temperature and humidity requirements.
    (c) Low temperature effect (chilling injuries).
    (d) Physiological and chemical changes.
    (e) Modified air storage.
(4) Precooling and transportation.

B. Equipment.

Projection slides and wall charts.

## RESPIRATION AND RESPIRATORY ENZYMES

A. Course Content (given only as an example to facilitate the use of the inventories).

(1) Fundamental concepts of respiration.
    (a) Gas exchange, respiratory quotient.
    (b) Respiratory substrates and end products.
    (c) Methods of measurement.
    (d) Comparative rates.
    (e) Factors affecting rate of respiration.
(2) Catalysis.
    (a) Energetics and kinetics.
    (b) The nature of electron transfer in oxidations.
(3) Respiratory enzymes.
    (a) Iron porphyrin proteins.
    (b) Flavin proteins.
    (c) Pyridine proteins.
    (d) Thiamine proteins.
    (e) Miscellaneous dehydrogenases and oxidases.
(4) Intermediary metabolism.
    (a) Metabolic cycles and enzyme cycles.
    (b) Anarobic and aerobic metabolism.
    (c) Phosphate transfer.

B. Equipment.

Projection slides and wall charts.

## TEMPERATE FORESTRY

A. Course Content (given only as an example to facilitate the use of the inventories).

Utility of forests.
Soil and climate of forest.
Parts of a tree: roots, crown, bole.
Methods of propagating trees: seeds, shoots, suckers, cuttings.

General aspect of forest plantations; simple coppice; selectively felled coppice; even-aged high forest; selection forest; composite forest.
Analysis of forest plantations: Study of the principal broad-leaved species: gregarious species, disseminated species; study of the principal coniferous species; synthesis of plantations: pure and mixed forests; examples.
General elements of management: forest capital (its elements, its variations with the age of the plantation); the yield; rate of increase and of financial return on money invested; possibilities (in extent, in volume); location of felling.
The simple coppice: culture, organizations, advantages and disadvantages of simple coppices.
The coniferous even-aged forest; sylviculture; organization by pure area, by age-groups, by shelter wood compartments.
The selection forest: sylviculture; organization by area, by volume.
The composite forest: method of constitution and composition; organization; cultivation.
Conversion of coppice to coniferous forest.
Afforestation and artificial replantation: Choice of species, choice of method of afforestation or replantation; seed plots.
Forest pasturing: its inconveniences, and control.
Wood mensuration: felled timber, standing timber.
Appraisal: of a forest estate, of a given area of forest; numerical examples, forest valuation.
The management of privately owned forests: forestry operations, organization of production; sale of fellings; exploitation and removal of fellings; defence against forest fires; laws relating to the management of privately owned forests.
Timber: technical properties, flaws and deterioration; preservations, uses.

B. Practical Work.

Recognition of the principal species and principal timber woods. Appraisal of the physical and mechanical qualities of timbers.

C. Equipment.

(1) *Demonstration equipment.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Films | — |
| 1 colln | Photographs | — |
| 1 colln | Wall pictures | — |
| 1 colln | Slides | — |
| 1 colln | Maps | — |
| 2 | Models of corrected stream flow, 80 × 60 × 40 cm | — |
| 1 | Pressler auger for measuring the rate of increase in volume of standing timber | 3.00 |
| 1 set | Equipment for tapping conifers: hapchot[1], pot, climbing iron | 4.50 |
| 1 | Forester's hammer | 3.00 |
| 1 | Auger | 1.20 |
| 1 colln | Samples of flaws and deterioration of timber | — |
| 1 | Model of strong sawing machine | — |
| | Total | 11.70 |

(2) *For practical work.*

Recognition of species is learnt during field trips and also with the help of fresh or preserved specimens in the laboratory.

| | | |
|---|---|---|
| 1 colln | Preserved specimens of the principal broad-leaved and coniferous species (leaves, fruit, seeds, bark, etc.) | — |
| 1 colln | Samples of wood of the principal species studied | — |
| 1 colln | Seeds | — |

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[1] The *hapchot*, also called *bridon*, is an axe used to incise the trunks of pines.

# TROPICAL FORESTRY

A. Course Content (given only as an example to facilitate the use of the inventories).

I. General forestry.
Review of basic elements of economics. The forest. Its two kinds of utility. Formation of forest products: preponderant role of natural forces, very subsidiary role of labour. Peculiar nature of the capital: capital and interest are of the same nature and indistinguishable from each other; forest capital is often collectively owned. Importance of the transport factor: forest products are heavy. Comparisons between forest and agricultural economy.

II. Tropical forest capital.

III. The products.
Woodland: Ecological role of woodland, its effect on climate, water control, and soil. Hygienic importance. Aesthetic importance. Protection of wild life.
Forest products proper: Production and consumption of timber throughout the world. Principal commercial species in the tropics. Production and export statistics. Tropical forest products other than timber.

IV. Forestry work.
Conceptions (forestry policy): History of relations between man and forest. Correct distribution of land between forest and agriculture. Substitution of some permanent cultures for transient cultures. Limitation of damage caused by bush fires. Valuation of existing forests. Reafforestation.
Forest control (forestry legislation): Justification for special legislation. Constitution of the forest domain. Relations with native population (rights of usage, cultivation, pasturage). Control of plantations. Clearing and reafforestation. Repression of infringements of the laws.
Direct forestry work (tropical sylviculture): Special difficulties. Necessity for action in spite of such difficulties. Principal treatments applied up to the present. Exploitation and sylviculture. Natural and artificial regeneration.

B. Practical Work.

Visit to a centre of research on tropical timbers.

# ZOOTECHNICS
## (temperate regions)

A. Course Content (given only as an example to facilitate the use of the inventories).

(1) General training.
(a) General zootechnics.
Introduction. Definition and principles.
Feeding: Conditions for rational and hygienic diet. Energy value. Nitrogen- and mineral values. Vitamin value. Food bulkiness. General conditions for nutritional balance. Toxic feeding stuffs. Watering. Preparation of feeding stuffs. Particular effects of certain feeding stuffs on the production of work, on the production of fat meat, and on milk production. Principal feeding stuffs for cattle and their conditions of use. Basis of the cost price of a diet.

Veterinary hygiene: Principal epizootic diseases. Principles of action against these diseases. Principal non-contagious diseases.

Reproduction: The rational bases of selection. The various methods of reproduction. Choice of parents. Technique of the control of aptitudes. Herd books. Natural and artificial insemination.

(b) Special and comparative zootechnics.

Bovine races: principal races. Methods of exploitation. Production of work. Meat production. Milk production. Techniques and methods proper to each of the above productions.

Ovine races: principal races. Methods of exploitation. Production of meat, wool, milk.

Porcine races: Principal races. Modern methods of exploitation.

Equine races: Principal races. Economic problems.

Poultry: Economic importance of poultry products. Methods of exploitation.

(2) Special training.

(a) Scientific section.

Supplementary course in general zootechnics: critical study of rational feeding systems at present in use in various countries. Conduct of research work on animal feeding. Bases of selection. Biometry. Research problems raised by the genetic improvement of domestic vertebrate species.

(b) Agricultural section.

Supplementary courses in animal ethnology and comparative zootechnics: Bovine races. Ovine races. Caprine races. Porcine, equine and poultry races. Zootechnics of the dog. Study of the principal markets for animal products. Meat, milk, wool, skins and furs, etc. Rational bases of selection. Biometry.

B. PRACTICAL WORK.

(1) General training.

(a) General zootechnics.

Appraisal of livestock. Study of the exterior of domestic animals. Determination of age and state of health. Appraisal of good qualities and defects. Examination of animals with a view to sale. Visits to farms having purebred herds, registered, and complying with regulations.

(b) Special and comparative zootechnics.

Ethnology of bovine, ovine and porcine races. Visits to markets, agricultural shows and exhibitions. Visits to livestock establishments.

(2) Special training.

(a) Scientific section.

Appraisal of livestock. Problems of animal feeding and genetics. Technique of control of yields. Visits to experimental and breeding stations dealing with selectively bred animals. Critical study of research work.

(b) Agricultural section.

Periods devoted to the application of knowledge acquired in the theoretical course to problems of animal production. Appraisal of livestock. Problems of animal feeding and genetics. Techniques of milk-butter control, wool control, control of suitability for meat production. Visits to stock-breeding establishments, to professional organizations and markets. Critical study of observations made during these visits.

C. EQUIPMENT.

(1) *Demonstration apparatus.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 250 | Diapositives | — |
| 60 | Wall pictures | — |
| 30 | Drawings | — |
| 1 colln | Maps of the world and of various countries | — |

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 colln | Animal feeding stuffs (70 bottles, 300 g capacity) | — |
| 1 | Skeleton of a horse | 173.00 |
| 1 | Skeleton of a cow | 173.00 |
| 1 | Skeleton of a sheep | 173.00 |
| 1 | Skeleton of a pig | 173.00 |
| 1 | Skeleton of poultry | 16.00 |
| 1 | Skeleton of a rabbit | 18.50 |
| 1 | Skeleton of a horse's head | 15.00 |
| 1 | Skeleton of a cow's head | 10.00 |
| 1 | Skeleton of a sheep's head | 4.00 |
| 3 | Skeletons of a pig's head | 21.00 |
| 1 | Skeleton of a rabbit's head | 3.25 |
| 1 | Model of a horse, plaster | — |
| 1 | Model of a cow, plaster | — |
| 1 | Yardstick, wooden | 10.00 |
| 1 pr | Castrating forceps | 20.00 |
| 1 | Sheep's fleece | — |
| 2 sets | Hand shearing apparatus for sheep | 4.00 |
| 1 | Electric milking machine, for demonstration | 360.00 |
| 1 | Apparatus for estimating the cleanliness of milk | 3.00 |
| 3 | Butyrometers | 6.00 |
| 1 | Thermolactodensimeter | 1.25 |
| | Total | 1,184.00 |
| (2) *Apparatus for practical work* (30 students). | | |
| 15 sets | Photographs of jaws at different ages (set of 12) | — |
| 20 | Horse's teeth | — |
| 20 | Sheep's teeth | — |
| 12 | Water baths, gas heated, 30 × 15 × 15 cm | 163.00 |
| 12 | Gas burners for above | 36.00 |
| 12 | Thermometers | 20.00 |
| 60 | Butyrometers, various types | 90.00 |
| 1 | Centrifuge, hand operated, for butyrometer, 12 tubes | 45.00 |
| 1 | Centrifuge, electrically operated, for butyrometer | 96.00 |
| | Total | 450.00 |
| (3) *Glassware.* | | |
| 30 | Pipettes, 1 cc | 13.00 |
| 10 | Pipettes, graduated in $^{1}/_{10}$ cc, 2 cc | 7.00 |
| 10 | Pipettes, 3.1 cc | 4.00 |
| 10 | Pipettes, 3.4 cc | 5.20 |
| 10 | Pipettes, 9.7 cc | 5.60 |
| 10 | Pipettes, 10 cc | 5.60 |
| 10 | Pipettes, graduated in $^{1}/_{10}$ cc, 10 cc | 8.00 |
| 10 | Pipettes, 11 cc | 5.60 |
| 10 | U tubes | 5.00 |
| 10 | Tubes with bungs and taps | 6.00 |
| 10 | Test tubes | 0.50 |
| | Total | 65.50 |
| (4) *Chemicals.* | | |
| 600 cc | Acid, sulphuric d = 1.820 | 1.50 |
| 100 cc | Alcohol, amyl | .20 |
| 100 cc | Alcohols, methyl and isobutyl | .50 |
| 50 cc | Formaldehyde | .20 |
| 150 cc | Hydrogen peroxide, 1% | .30 |
| 100 cc | Mixture, methyl alcohol, isobutyl alcohol, ether and dye | .75 |
| 50 cc | Phenolphtalein | .50 |
| 500 cc | Soda, caustic (0.625 g/l) | 1.25 |
| 500 cc | Soda, cautsic (0.745 g/l) | 1.25 |
| 100 cc | Soda, caustic (Dornic, 4.45 g/l) | .50 |
| 500 cc | Seignette salt | 2.50 |
| | Total | 9.45 |

# STOCKBREEDING AND ZOOTECHNICS IN THE TROPICS

A. Course Content (given only as an example to facilitate the use of the inventories).

This course is given to students who have already taken courses in general and special zootechnics over a number of years. Its aim therefore is to deal above all with methods of production, of working and of improvement of stock in the tropics.

Importance of stockraising in tropical countries.
  Statistics concerning livestock in tropical countries. Complexity and difficulty of stockraising in these territories. Importance of parasitic diseases. Main migration movements; main trade routes.
Climatology in relation to zootechnics in tropical countries.
  Hot climates; their main aspects. The effect of environment on the animal. Effect of climate on the distribution of species, races, individuals. Acclimatization: its aims, mechanism, essential factors and results.
Hygienic factors in the improvement of animal species.
  Plant and animal economy: characteristics peculiar to the Tropics.
Animal feeding in tropical countries.
  Particular characteristics, dry season, wet season. Principal deficiencies: calorific, vitamin, mineral. Food of animals in the Tropics. Fodder production; difference from temperate countries; problem of improvement. Natural pasturages: forest, bush; dry, wet, flooded lands; fodder from shrubs, their utilization (bush fires). By-products of tropical agriculture: cereal stubbles and straws (value, precaution, accidents); tops of leguminous plants (groundnuts, beans, doliques); fodder tubers (manioc, sweet potatoes, etc.); miscellaneous: stalks, brans, cakes, etc. Harmful and doubtful fodder. Preservation and reserves of feeding stuffs: fodder, silage, salting. Toxic plants in the tropics.
Watering.
  Its importance and difficulties. Purification of water.
Housing of animals in tropical countries.
  Different types of house or shelter. Fences and pens. Litters and manure heaps.
Bodily hygiene.
  Hygienic and parasitic baths. Clipping. Other bodily care. Hygiene of work in hot countries.
Hygiene in open air life.
  Protection against heat, light, insects.
Zootechnical factors in the improvement of animal species.
  Reproductive methods; crossing, selection, their value in the tropics, means of effecting them. Methods of artificial insemination: importance, techniques, results to be expected. Methods of stockraising: suckling and weaning, maintenance, exploitation, causes of backwardness in tropical livestock.
Social factors in the improvement of animal species.
  Organization of livestock raising; stock groupings; native population groupings; provident societies; export groups.
Zootechnical study of animal production in tropical countries.
  Buffalo, Zebra, Camel, Dromedary, Elephants, Ostriches.

B. Practical Work.

Projections of slides with commentary (ethnology, methods of exploitation).
Visits to livestock shows (competitions) and to large centres for supplying animals, particularly to pick out the races of the various species (including poultry), suitable for use as improvers in the tropics.
Demonstrations of artificial insemination, mainly in cattle; collecting the semen, control, preservation, transport, insemination.

C. EQUIPMENT (for 35 students).

(1) *Demonstration apparatus.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 colln | Wall pictures (genetics and appreciation of animals) | 30.00 |
| 400 | Diapositives | 240.00 |
| | Total | 270.00 |

(2) *Laboratory apparatus.*

| | | |
|---|---|---|
| 1 | Oven at 25° C, electric, 48 × 40 × 60 cm | 119.00 |
| 5 | Zoometric tapes for large animals | 2.00 |
| 5 | Zoometric tapes for small animals | 2.00 |
| 5 | Rods for measuring height of large animals | 36.00 |
| 5 | Rods for measuring height of small animals | 30.50 |
| 35 | Microscopes with eyepiece micrometers | 6,300.00 |
| 5 | Precision balances, sensitivity 1/20 mg | 1,000.00 |
| 1 colln | Wool samples | — |
| 1 colln | Photographs | — |
| 5 | Ovens at 40° C, electric, 48 × 40 × 60 cm | 595.00 |
| 35 | Haematometers | 472.50 |
| 5 | Hot stages, for microscopes | 125.00 |
| 3 | Artificial vaginas | 41.00 |
| 5 | Syringes for artificial insemination | 33.00 |
| 1 | Cabinet for diapositives | 15.00 |
| | Total | 8,771.00 |

## FIFTH PART

# ECONOMICS

# STATISTICS

A study of the principles involved in the collection, tabulation, and interpretation of agricultural and marketing statistics.

A. Course Content (given only as an example to facilitate the use of the inventories).

(1) Collection of data.
  (a) Surveys, sampling.
  (b) Records, published statistics.
(2) Summarization of data.
  (a) Frequency distribution.
  (b) Measures of central tendency.
  (c) Measures of dispension.
  (d) Punched Card method.
(3) Analysis of relationships.
  (a) Tabulation.
  (b) Correlation.
(4) Analysis of time-series.
  (a) Index numbers.
  (b) Secular trend.
  (c) Cycles.
  (d) Seasonal variation.
(5) Testing reliability of results.
  (a) Tests of significance.
  (b) Setting confidence limits.
  (c) Analysis of variance.
  (d) Tests of goodness of fit.
(6) Presentation of results.
  (a) Tables.
  (b) Charts and graphs.

B. Laboratory Work and Practical Work.

(1) Weekly laboratory exercises.
(2) Term problem; student opinion survey.
  (a) Collection of data.
  (b) Analysis of data; use of punched card statistical machinery.
  (c) Report of results.
(3) Examinations.

C. Equipment (60 students).

(1) *Demonstration Equipment.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 colln | Projection slides on tables, charts and graphs . . . | — |

(2) *Laboratory Apparatus.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 15 | Calculating machines, electric . . . . . . | 11,850.00 |

The following apparatus can either be purchased or rented from special firms. Rentals or sales prices vary from one maker to another and also depend on the countries in which the machines are to be installed. The following prices therefore, should be regarded as indicative only.

| Quantity | Item | Price in dollars<br>Rentals<br>Initial deposit | <br>Rentals<br>Monthly rental | Sales |
|---|---|---|---|---|
| 3 | Cardpunchers | 291.00 | 52.00 | 2,910.00 |
| 3 | Verifiers | 291.00 | 52.00 | 2,910.00 |
| 2 | Sorters | 460.00 | 82.80 | 4,600.00 |
| 2 | Tabulators | 3,359.00 | 302.30 | 33,590.00 |

# AGRICULTURAL LAND ECONOMICS

A. Course Content (given only as an example to facilitate the use of the inventories).

(1) Introduction.
    (a) Definition of Agricultural Land Economics as a field of specialization.
    (b) Its relationship to other fields.
    (c) Land economics and land variability.
    (d) The study of land variability and its economic implications through classification.
(2) Important economic concepts and ideas.
    (a) Production functions.
    (b) Analysis of production functions: arithmetically, geometrically and symbolically.
    (c) Economic implications of production functions.
(3) The economic consequences of differences in land.
    (a) The representation of land differences as production function differences.
    (b) The traditional theory of land use and farming returns.
    (c) Empirical tests of traditional conclusions.
    (d) Why the discrepancies between traditional theory and reality?
    (e) A revised theory of land use and farming returns.
(4) Economic principles and the economic classification of land.
    (a) Types of economic classification.
    (b) The history of economic-returns classifications.
    (c) Theoretical and practical aspects of income-expectancy systems.
    (d) An appraisal of economic-returns classifications.
    (e) Land classifications by kind of land use.
(5) Patterns of economic change.
    (a) Overall patterns of change.
    (b) Patterns of change upon the land.
    (c) Nonfarm currents in the rural picture.
    (d) The outlook for the future.
(6) The institutional side of land economics.
    (a) The general nature and composition of our institutional framework.
    (b) How the institutional climate modifies land use and farming returns.
    (c) Relative flexibilities in the institutional framework.
    (d) Recent institutional changes designed to modify land use and farming returns.

(7) Conservation principles and problems.
  (a) What is conservation?
  (b) The social-time-preference concept.
  (c) The role of government in conservation.
  (d) Economic aspects of conservation.
(8) Elements in a land policy.
  (a) The nature of policy.
  (b) Evidences of an active land policy.
  (c) Promotional policies.
  (d) General trends in land policies.

B. Laboratory Work and Field Trips.

The laboratory period provided for in the course is used as a discussion period except when field trips are held. Laboratory exercises are assigned each week and are to be done outside class. They involve assigned reading, the answering of questions on subjects under discussion and the working of illustrative problems. Two half-day field trips are taken. Trip routes are laid out to illustrate land variability and the economic consequences thereof under prevailing conditions.

C. Equipment.

(1) *Demonstration apparatus.*

Charts are used to illustrate the nature of production functions and their economic implications. Numerous maps are presented to illustrate various types of land classification and the procedural steps involved in them. Coloured 35-millimetre slides could be used to very good advantage to illustrate land variability, visible evidences of differences in farming returns, realistic factor-combination problems, and numerous other points. A collection of slides now is neing made for this purpose.

(2) *Laboratory equipment.*

The laboratory exercises refer to numerous bulletins and reports of studies made in land classification and other branches of the field. It is necessary, therefore, that the library have an adequate supply of these.

(3) *Equipment for field trips.*

A portable public address system is used on the field trips. Through this the instructor keeps up a running commentary as the bus moves along. The field trips emphasize area-wide differences in land and farming, emphasize area-wide perspective rather than the details the students are expected to have become familiar with in other courses. An appreciable mileage is covered on each trip and few stops are made. For these reasons a running commentary is especially valuable. One public address system should be provided for each bus.
Price of a portable public address system comprising a microphone, an amplifier and a loudspeaker, $100.

## FARM MANAGEMENT

A. Course Content (given only as an example to facilitate the use of the inventories).

(1) Introduction.
What farm management is.
History of the development of the subject.
Methods of studying farm management.

(2) How to study a farm business.
Summarizing the records of a year's business.
Measures of profits.
Farm business analysis.
Farm records.

(3) Factors affecting profits.
- (a) Prices.
  The general price level, changes in relative values of farm products, cycles.
- (b) Size of business:
  General relationship, variations in this general relationship, reasons for this general relationship, limits to size and reasons, large-scale farming, national welfare, ways of enlarging the business, adjusting the size of business to changing economic conditions.
- (c) Rates of production of crops and animals:
  General relationship, reasons for this relationship, limits to yields and reasons, ways of improving production, adjustment to changing economic conditions.
- (d) Selection and combination of enterprises:
  Factors to consider in determining the best combination of enterprises: relative profits of different enterprises, labour distribution, amount of untillable land, use of by-products, maintenance of productivity, rotation, risk, distribution of income, use of buildings and equipment, capital, personal factors.
- (e) Labour efficiency:
  Relation to profits and reasons, ways of improving labour efficiency.
- (f) Farm layout, farmstead and building arrangement.
- (g) Efficiency in the use of farm equipment.
- (h) Markets and marketing.

(4) Starting farming.
Personal requirements, preparation, choosing a farm, getting control of capital, contracts, insurance, home farm.

B. Laboratory Work and Field Trips.

(1) How to summarize a record and calculate profits.
(2) Analysis of the business.
(3) Cash accounts.
(4) The effect or price changes on a farm business.
(5) Profit-sharing arrangements.
(6) Inventory and valuation (field trip).
(7) A study of farm management information on dairy, poultry, or fruit farms. Preparation of standards for a good farm business.
(8) Visit a good farm which is for sale. Problem in organizing the farm as you would have it if you owned it. Detailed plans of rotation, livestock, layout, buildings.
(9) Additional problem on the above farm. Budget and financial plan for a year's operation.
(10) Trip to study type of farming adjustments.
(11) Planning the reorganization and combination of farms in an area where type-of-farming adjustments are needed. Home farm problems.
(12) Trip to study methods of getting started in farming.
(13) A study of some excellent farm businesses.
(14) Trip to study the problems of farming on marginal land.

C. Equipment.

(1) *Demonstration apparatus.*

No special equipment is used in the lectures, but mimeographed results of research studies are used to a large extent.

| Quantity | Item | Total cost in dollars |
|---|---|---|
| 1 | Mimeograph machine . . . . . . . | 286.00 |
| 1 | Typewriter . . . . . . . | 149.50 |
| | Total | 435.50 |

(2) *Equipment for field trips.*

| Quantity | Item | Total cost in dollars |
|---|---|---|
| | Aerial photographs (for preparing farm maps) | — |
| 5 | Measuring tapes, 20 m | 17.50 |
| 5 | Soil augers, 1 m, 3 cm diam | 20.00 |
| | Total | 37.50 |

## FARM APPRAISAL

A. Outline of the Course (given only as an example to facilitate the use of the inventories).

Farm appraisal procedure (trip).
Farm appraisal practice (trip).
The appraisal of a farm with low productivity (trip).
The appraisal of an out-of-type-farm (trip).
Poultry farm appraisals (trip).
The appraisal of an excellent farm (trip).
Summary of appraisals.
Preliminary examination. Why land has value. Land value theory.
Lecture and discussion by a professional appraiser operating in the vicinity.
Land valuation methods advanced by different authorities. A study of these methods with reference to the farms appraised.
Procedure for starting appraisals in a new area.
Lecture and discussion by an executive of organization making appraisals in a wide range of territory.
Deed and mortgage records as a source of basic information for appraisers.
Summary and Review.

B. Practical Work.

An outside report is assigned each week and is discussed during the following week.

C. Equipment.

Same as used for "Farm management".

## FARM FINANCE

A. Course Content (given only as an example to facilitate the use of the inventories).

(1) The setting in which farms are financed.
  (a) The family farm.
  (b) Some contrasts between farms and other business: amount of capital; turnover of capital; risk; return on capital.

(2) What is good finance for the farmer.
  (a) Proportions borrowed.
  (b) Repayment terms.
  (c) Costs.
(3) Historical development of agricultural credit.
(4) Definitions of credit instruments and terms.
(5) Farm mortgage credit.
  (a) Amount and relation to economic conditions.
  (b) Regional variations.
  (c) Sources.
  (d) Repayment terms.
  (e) Interest charges.
(6) Farm mortgage credit agencies.
  (a) Individuals.
  (b) Banks.
  (c) Mortgage Companies.
  (d) Life Insurance Companies.
  (e) Governmental Agencies.
(7) Production credit.
  (a) Amounts used.
  (b) Terms.
  (c) Rates.
  (d) Important agencies.
(8) Credit for farmer co-operatives.
(9) Suggestions on wise use of credit.

B. LABORATORY WORK.

The laboratory work requires no special equipment. It is merely problems and assignments co-ordinated with the lecture and other reading.

## FARMERS' CO-OPERATIVES

A. COURSE CONTENT (given only as an example to facilitate the use of the inventories).

(1) What is a co-operative?
  (a) Business corporation.
  (b) Purpose.
  (c) Control.
  (d) Distribution of benefits.
  (e) The Rochdale Principles.
  (f) Other definitions.
(2) What they do.
  (a) Historical sketch of farmers' co-operatives.
  (b) Business now being done.
(3) Objectives of farmers' co-operatives.
  (a) Reduce the spread.
    (1) Get existing profits for farmers.
    (2) Eliminate services.
    (3) Reduce unit costs.

- (b) Improving returns by marketing programmes.
    - (1) Making the best of the market as it exists.
    - (2) Attempting to demand higher prices — monopoly or semi-monopoly.
    - (3) Bargaining.
    - (4) Improving demand for the co-operative's product.
- (c) Other objectives.

(4) Sharing the costs and benefits (pooling).
- (a) The problem and general principle.
- (b) Length of pools.
- (c) Quality pools.
- (d) Sharing expenses.
- (e) Paying producers.
- (f) Other methods of operation.

(5) Financing co-operatives.
- (a) Standards of corporate financing.
- (b) Capital requirements of co-operatives.
- (c) Sources—outside vs. members.
    - (1) Borrowing from outside.
    - (1) Capital from members.

(6) Legal status.

(7) Internal organization.
- (a) Lines of authority: members; → directors; → manager; → employees.
- (b) Directors.
- (c) Management.

(8) Relations with members and the public.
- (a) Membership relations.
- (b) Public relations.

(9) When should a co-operative be formed?
- (a) What is the co-operative to do?
- (b) What are the chances for doing it?
- (c) Are the opportunities worth the effort and risk?
- (d) If answers in affirmative.
- (e) Procedure in actual forming of co-operative.

(10) The role of co-operatives.
- (a) A contrast in philosophies.
- (b) The future of farmers' co-operatives.

### B. Laboratory Work and Field Trips.

The laboratory work consists of a series of problems and assignments which are coordinated with the lecture and other reading material.
Fields trips consist of visits to co-operatives existing in the vicinity.

## FOOD ECONOMICS

This is a one semester course consisting of a series of forty-five lectures. Students are assigned a certain amount of library work and supplemental readings in the rather diverse literature pertaining to population problems, food supplies, food production and food distribution. The course does not have a laboratory section. The course has been designed for, and is offered primarily for students who are majoring in the technical field of nutrition in the College of Home Economics and in the School of

Nutrition. For the most part, these are students who have very little, if any, training in economics or other aspects of the social sciences. Neither can it be assumed, as we have found from experience, that very many of the students who take the course have very much background in agriculture. Therefore, the presentation has to begin at an elementary level both in the economic materials discussed and in questions of technical agriculture.

A. COURSE CONTENT (given only as an example to facilitate the use of the inventories).

I. Food and people.
  (1) Food population problems in major world areas.
    (a) Southeast Asia.
    (b) Europe.
    (c) United States of America.
    (d) The major exporting countries: Canada, Argentina, Australia and New Zealand.
    (e) The tropical and Colonial areas.
  (2) Food consumption patterns in various countries.
    (a) Data published by the Food and Agriculture Organization of the United Nations.
    (b) Consumption measured by dry-weight and wet-weight bases.
    (c) Plant foods and animal product foods.
  (3) Population questions.
    (a) Malthus and his doctrine.
    (b) Post-Malthusian developments.
    (c) Current vital statistics and demographic patterns.
    (d) Population predictions.
  (4) The future food supply.
    (a) Factors involved in increasing food production.
    (b) Prospects in the United States.
    (c) Prospects in other major countries and regions varying in their economic development and development trends.
II. The economics of food production.
  (1) The characteristics of agriculture as an industry.
    (a) A biological industry governed in large part by physical and biological conditions.
    (b) The economics of farm organization.
    (c) Commercial and subsistence farming.
    (d) Comparative stability of food production.
  (2) Factors affecting successful farm organization under differing conditions of economic, social and technical development.
III. Food marketing and distribution.
  (1) The origin of marketing problems.
  (2) The marketing system in highly developed countries.
  (3) The problem of price.
    (a) How price is determined for agricultural commodities.
    (b) The general price level and relation to agricultural prices.
    (c) Cyclical, secular and seasonal price changes.
  (4) The marketing spread.
    (a) The costs of marketing.
    (b) The "market basket" concepts.
    (c) Differences in marketing costs by commodities.
    (d) Reducing the marketing spread.
IV. Economics of the diet.
  (1) Food habits in the country under study.
    (a) Factors causing differences in food habits.
    (b) Developments that have altered dietary patterns.
  (2) Food expenditures and income.
    (a) Consumer incomes and food expenditures.
    (b) Changes in food purchases as related to changes in income.
    (c) The "luxury index".

(3) Using national agricultural resources to meet food needs.
  (a) Yield of food nutrients per unit of land and labour from different food products.
  (b) Need for a balanced agriculture to produce a balanced diet.
(4) Review of food supply and nutrition prospects.

B. Equipment.

In addition to a few maps and access to a rather wide field of literature on population, agriculture and economic topics, no special materials are required for the course.

## MARKETING DAIRY PRODUCTS

A. Course Content (given only as an example to facilitate the use of the inventories).

First part: Basic facts and principles of dairy marketing.
(1) Nature and importance of the dairy industry.
  Importance of milk as source of farm income and food supply.
  Leading products and divisions of the industry.
  Some characteristics of the milk industry that influence the content of this course.
(2) Milk constituents and dairy processes.
  Relative importance and principal uses of fat and solids-not-fat.
  Processes for converting milk into various main products and by-products.
  Products yields, conversion factors and milk equivalents.
(3) How supplies and consumption of dairy products are balanced nationally.
  Long-time changes in population and in the production and consumption of milk.
  Changes in utilization of the milk supply.
  Imports and exports of dairy products.
  Tariffs and other restrictions on imports.
  Government purchases for export, military use, and price stabilization.
  Seasonal variation in production, consumption and storage.
(4) Milk utilization—nationally and regionally.
  Disposal of milk by farmers.
  Utilization by dairy plants.
  Regional differences in farm returns for milk and butterfat.
  Economic factors affecting the utilization and prices of milk and butterfat in different areas.
(5) The dairy regions.
  Characteristics of the region with respect to the production and utilization of milk.
  Variations in the production and utilization of milk within the region.
  Local production and shipped-in supplies of the several kinds of dairy products.
  Milksheds of the major markets and secondary markets.
  The influence of health department regulations and other control measures on the production, utilization, movement and prices of milk and cream.
(6) The marketing system—trade organization.
  Trade channels for butter, cheese, canned milk, fluid milk, ice cream.

- Marketing agencies and their functions.
- Significant developments, such as large-scale organization, co-operative marketing, chain store distribution, and the increasing role of government in marketing.
- Large dairy companies.
- Trade associations and their functions.
- The role of co-operatives in marketing dairy products.

Second part: Marketing problems in the fluid milk industry.

(7) Maintaining or increasing the demand for milk and related products.
- Characteristics of demand for milk and other products.
- Rates of consumption in various areas and among different groups of people.
- Changes in rates of consumption over time.
- Effect of income, price, weather, and other factors.
- Competition between fresh milk, canned milk and dried milk; between butter and margarine.
- Ways of promoting increased demand for milk and its products—industry organizations and their programmes; publicly supported programmes; new products, new and improved packages, and new methods of distribution.

(8) Obtaining adequate supplies of milk and cream and keeping these supplies in proper adjustment with sales.
- The problem of surpluses and shortages.
- Seasonal surpluses and shortages.
- Ways of adjusting production and demand seasonally.
- Utilization of seasonal surpluses.
- Storage cream and reconstituted milk.
- Seasonal adjustments of milk production.
- Divergent trends of production and consumption—causes, and means of correction.
- Possibilities of forecasting milk production.

(9) Determining proper prices to be paid by dealers and proper methods of distributing the payments to producers.
- Evolution of pricing methods.
- Development of producers' organizations and collective bargaining.
- Development of classified prices, base-surplus prices, formula pricing, various price differentials, and pooling.
- Conditions that led to public regulation of milk prices.
- Milk control programmes.
- Objectives in setting producer prices, and criteria used.
- Formula pricing, pooling (equalization), etc.
- Inter-market price relationships.
- Other problems involved in public administration of milk prices.
- Market reports and other sources of information on prices of dairy products and related factors.
- Basic price quotations for dairy products, how determined—are they adequate?

(10) Equitable pricing of milk and related products to consumers and others.
- Considerations in determining the level of prices.
- Price differentials based on kind or amount of service, kind and size of package, customer volume, etc.
- Seasonal changes in price.

(11) Maintaining or increasing efficiency in the handling, processing and distribution of milk and related products.
- The farmer's share of the consumer's dollar, for milk and other products.
- The distributor's spread on milk: margins, costs, and profits.
- Components of the consumer's price: costs of the several marketing services.
- Ways of increasing efficiency of country handling, transportation, processing and delivery.
- The importance of labour efficiency and ways of increasing it.

(12) Application of the foregoing facts and principles to the organization and management of a dairy enterprise.
(To be developed by each student in a term paper.)

(13) Summary.

B. Laboratory Work and Field Trips.

(1) Constituents of milk, dairy processes, and milk equivalents.
(2) Geography of milk production and utilization.
(3) Principles governing the utilization of milk in different areas.
(4) The marketing system for fluid milk and cream.
(5) Co-operative marketing of dairy products.
(6) The dairy regions: Production and utilization of milk; location of principal markets and milksheds.
(7) Operating and financial reports of large dairy companies.
(8) The supply side of the milk market.
(9) How milk is priced.
(10) Milk control programme.
(11) Regulation of milk prices.
(12) Sources of information on prices, supply and demand for dairy products—market reports.
(13) The spread between farm and retail prices of milk.
(14) Field trip to study the set-up and operation of a fluid milk receiving plant.
(15) Field trip to study the set-up and operation of milk pasteurizing and bottling plant.

C. Equipment.

Lantern slides and film strips are used to a limited extent in connexion with discussions of the geography of milk utilization and the marketing system for dairy products. A large number of mimeographed tables and charts are used to illustrate subject matter covered in lectures and laboratory exercises. Also, a considerable number of Experiment Station bulletins and other published material is used for reference purposes.

## MARKETING POULTRY, EGGS AND LIVESTOCK

A. Course Content (given only as an example to facilitate the use of the inventories).

(1) Introduction.
    (a) Definition of terms.
    (b) Characteristics of agriculture related to poultry, eggs, and livestock marketing.
    (c) Characteristics of livestock products related to marketing.
    (d) Characteristics of consumers related to marketing.
    (e) Historical development of marketing.
(2) Importance of poultry, eggs, and livestock to marketing and to economy as a whole.
(3) Demand.
    (a) Nature of demand.
    (b) Luxuries versus necessities and consumers' reaction to income changes.
    (c) Basic reasons why livestock products are expensive.
    (d) Consumption of meat and eggs in the country.
    (e) Consumption of meat and eggs by various countries.
    (f) Factors that affect quantity and kinds of products consumed.
    (g) Future demand for poultry, eggs, and livestock products.
(4) Supply.
    (a) Why we are concerned with supply.
    (b) Why farmers produce what they do where they do.

- (c) Areas of production for various types of poultry, eggs and livestock.
- (d) Implication to marketing of the location of production areas.
- (e) Variation in supply—trends, cycles and seasonal variations.
- (f) Miscellaneous problems of supply.

(5) Balancing supply and demand.
- (a) Market prices.
- (b) Exports and imports.
- (c) Government programmes.
- (d) Storage.
- (e) Transportation.
- (f) Markets and market agencies.

(6) Marketing costs.
- (a) Cost of food marketing.
- (b) Farmer's share of the consumer's dollar.
- (c) Factors which affect marketing costs.
- (d) Make-up of the marketing margin.
- (e) Why cost of marketing is high.

(7) Reducing marketing costs.
- (a) Factors that determine income to farmers from the marketing of their produce.
- (b) Ways of reducing marketing costs.
- (c) Resistance to reducing costs.
- (d) Benefits of cost reduction.

## B. LABORATORY WORK AND FIELD TRIPS.

Laboratories include field trips, either half day or all day, and discussion periods. The latter usually entail discussion of an exercise which has been prepared by the students outside of class, using source material designated on the exercise. The exercises are often of a problem type. The discussion periods are usually two hours in length.

(1) Sources of marketing information.
- (a) Kinds of reports.
- (b) Interpreting price quotations and market statistics.

(2) Future trading.
- (a) Discussion of the functions and purposes of future trading.
- (b) A practical exercise lasting all term involving mock future trading by the students. Complete records of each student's profits and losses are kept.

(3) Classes and grades.
- (a) Objectives of grades and standards.
- (b) Requirements for satisfactory standards.
- (c) What is involved in classifying and grading.
- (d) Does it pay to grade?
- (e) Where should grading be done?
- (f) Government grading.

(4) Prices and pricing.
- (a) Significance of dressing percentages, retail markup and differences in value between different products.
- (b) Significance of concentration of values and use of otherwise unusable materials in the marketing of livestock products.

(5) Price ratios and their significance to marketing.

(6) Farm management practices related to marketing.

(7) Retail selling by producers.
- (a) Type of product sold.
- (b) Major considerations in producer retailing.
- (c) Containers used.

(8) Marketing practices and egg quality.

(9) Coloured slides of the production and marketing of poultry, eggs, and livestock in various sections of the country. Background material was given orally as the slides were shown.

(10) Trip to an egg receiving station.
(11) Trip to a slaughtering plant.
(12) Trip to a livestock auction.
(13) Wool—economic and marketing aspects of the wool industry and description of wool processing.
(14) Coloured movie, and discussion of operations of large scale packing plants.

C. Equipment.

Films and slides on livestock and poultry marketing obtained in personal contacts with various marketing agencies.

## MARKETING FRUITS AND VEGETABLES

A. Course Content (given only as an example to facilitate the use of the inventories).

(1) An analysis of the position of the fresh fruit and vegetable business in comparison with other foods.
(2) Detailed discussion of the history of the fresh fruit and vegetable industry.
(3) Discussion of the wholesaling of fresh fruits and vegetables in large cities, going into detail as to methods of operation, costs, etc.; methods of selling; types of agencies, and so forth.
(4) In a similar manner the jobbing of fresh fruits and vegetables in large terminal markets is discussed.
(5) Discussion of the retailing of fresh fruits and vegetables in large and small cities.
(6) Terminal facilities in key markets, and how such facilities might be improved for greater efficiency.
(7) The handling of fruits and vegetables at country shipping points. Each type of assembling and sales agency is carefully discussed with respect to specific commodities. This discussion covers methods of sale, costs in so far as they are available, warehousing, utilization, and areas of distribution and competition.
(8) The role of transportation agencies such as railroads, motor trucks, and boats in the handling of fresh fruits and vegetables, and their advantages and disadvantages as a means of transportation for such products.
(9) Major problems in the field of the marketing of fruits and vegetables, and some suggestions as to what can be done to solve them.

B. Laboratory Work.

(1) An analysis of the fruit and vegetable supply in large cities as to kind, source, method of transportation, place where produce was received, seasonal character of receipts, and so forth.
(2) An analysis of current crop estimates and the application of price formulae to the forecasting of potato prices.
(3) An analysis of current price research covering a number of fruits and vegetables.
(4) An analysis of the supply of and probable demand for apples.
(5) An analysis of trends in production and demand for apples.
(6) An analysis of commercial rating books generally used in the fresh fruit and vegetable business.

(7) An analysis of produce law as it relates to the fresh fruit and vegetable business.
(8) An analysis of marketing agreements as a means of stabilization and regulation of the fruit and vegetable industry.
(9) An analysis of government price support programmes for fresh fruits and vegetables.
(10) An analysis of the supply of and demand for citrus fruits, peaches and pears, as well as important shipping areas and the leading sources of supply.

C. EQUIPMENT.

*Demonstration apparatus.*

Lantern slides and film strips.

# APPENDIX I

## ABBREVIATIONS

A = ampere
AC = alternative current
Ah = ampere hour
AR = analytic reagent
BC = bayonet cap
b.p. = boiling point
BSC = bakelite screw cap
C = celsius
cc = cubic centimetre
cm = centimetre
colln = collection
comml = commercial
conc = concentrated
cryst = crystallized
d = density
DC = direct current
DCC = double cotton covered
diam = diameter
doz = dozen
° F = degree Farenheit
FB = flat bottom
FS = flat stopper
ft = foot
g = gram
gal = gallon
g/l = grams per litre
gran = granulated
HP = horse power
hpz = hectopieze
hr = hour
ht = height
$in^2$ = square inch
kg = kilogram
km = kilometre
kV = kilovolt
kW = kilowatt
L = lipped
l = litre
lb = pound
l/sec = litres per second
m = metre
$m^2$ = square metre
$m^3$ = cubic metre
mA = milliampere
max = maximum
mg = milligram
min = minute
ml = millilitre
mm = millimetre
mp = melting point
NM = narrow mouth
NMFS = narrow mouth flat stopper
NN = narrow neck
op = over proof
oz = ounce
obj = objective
ocul = eyepiece
P = pyrex
pkg = package
pr = pair
pptd = precipitated
RB = round bottomed
rpm = revolution per minute
sec = second
SF = squat form
SFL = squat form lipped
soln = solution
SWG = standard wire gauge
synth = synthetic
t = ton
temp = temperature
TF = tall form
V = volt
VA = voltampere
W = watt
winch = winchester quart
WM = wide mouth
WMFS = wide mouth flat stopper
WN = wide neck

# APPENDIX II

## CONVERSION FACTORS

*Length*

1 mm = 0.03937 in
1 cm = 0.3937 in
1 m = 3.2808 ft
= 1.0936 yd
1 km = 0.6213 mile

1 mil = 1/1000 in
= 0,0254 mm
1 in = 25,4 mm
1 ft = 12 in
= 30,48 cm
1 yd = 3 ft
= 0,9144 m
1 mile = 1609,3 m
1 line = 1/12 in
= 2,116 mm

*Surface*

1 mm$^2$ = 1973·5 circular mils
1 cm$^2$ = 0.155 in$^2$
1 m$^2$ = 10.7639 ft$^2$
= 1.1959 yd$^2$
1 km$^2$ = 0.3861 mile$^2$
= 247.11 acres
1 hectare = 2.4711 acres

1 circular mil = 0,0005067 mm$^2$
1 in$^2$ = 6,4516 cm$^2$
1 ft$^2$ = 144 in$^2$
= 0,0929 m$^2$
1 yd$^2$ = 9 ft$^2$
= 0,83613 m$^2$
1 acre = 4046,9 m$^2$
1 mile$^2$ = 1640 acres
= 2,5899 km$^2$

*Volume*

1 ml = 1 cm$^3$ = 0.06102 in$^3$
1 l = 1 dm$^3$ = 0.0353 cubic feet
1 m$^3$ = 35·3156 ft$^3$
= 1·3079 yd$^3$

1 in$^3$ = 16,387 cm$^3$
1 ft$^3$ = 28,317 dm$^3$
1 yd$^3$ = 0,76456 m$^3$

*Capacity*

1 l = 35·196 British fluid ounces
= 1·75981 British pints
= 0.2199 British gallons
= 33·8140 U.S. fluid ounces
= 2.1134 U.S. pints
= 0.2642 U.S. gallons

1 British fluid ounce = 0,0284 l
1 British pint = 0,5682 l
1 British imperial gallon = 8 British pt
= 4,5459 l
1 U.S. fluid ounce = 0,02957 l
1 U.S. pint = 0,4732 l
1 U.S. gallon = 3,7854 l
1 Winchester-quart = 80 British fluid ounces = 2,2729 l

*Weight*

1 g = 0.035 oz
1 kg = 35·273 oz
= 2.2046 lb

1 oz = 28,35 g
1 lb = 453,5 g
1 cwt = 50,802 kg
1 oz troy = 31,103 g

*Power*

1 kW = 1·341 HP

1 HP = 0,7457 kW

*Pressure*

1 kg/cm$^2$ = 14.223 lb/in$^2$

1 lb/in$^2$ = 0,070307 kg/cm$^2$
= 95,760 pz

## THE ELEMENTS[1]

| | | Atomic Number | Atomic Mass | | | Atomic Number | Atomic Mass |
|---|---|---|---|---|---|---|---|
| (Nn | Neutron | 0 | 1.0088) | Sn | Tin | 50 | 118.70 |
| H | Hydrogen | 1 | 1.0080 | Sb | Antimony | 51 | 121.76 |
| He | Helium | 2 | 4.003 | Te | Tellurium | 52 | 127.61 |
| Li | Lithium | 3 | 6.940 | I | Iodine | 53 | 126.92 |
| Be | Beryllium | 4 | 9.02 | Xe | Xenon | 54 | 131.3 |
| B | Boron | 5 | 10.82 | Cs | Caesium | 55 | 132.91 |
| C | Carbon | 6 | 12.010 | Ba | Barium | 56 | 137.36 |
| N | Nitrogen | 7 | 14.008 | La | Lanthanum | 57 | 138.92 |
| O | Oxygen | 8 | 16 | Ce | Cerium | 58 | 140.13 |
| F | Fluorine | 9 | 19.00 | Pr | Praseodymium | 59 | 140.92 |
| Ne | Neon | 10 | 20.183 | Nd | Neodymium | 60 | 144.27 |
| Na | Sodium | 11 | 22.997 | Pm | Promethium | 61 | 147 |
| Mg | Magnesium | 12 | 24.32 | Sm | Samarium | 62 | 150.43 |
| Al | Aluminium | 13 | 26.97 | Eu | Europium | 63 | 152.0 |
| Si | Silicon | 14 | 28.06 | Gd | Gadolinium | 64 | 156.9 |
| P | Phosphorus | 15 | 30.974 | Tb | Terbium | 65 | 159.2 |
| S | Sulphur | 16 | 32.066 | Dy | Dysprosium | 66 | 162.46 |
| Cl | Chlorine | 17 | 35.457 | Ho | Holmium | 67 | 164.94 |
| A | Argon | 18 | 39.944 | Er | Erbium | 68 | 167.2 |
| K | Potassium | 19 | 39.096 | Tm | Thulium | 69 | 169.4 |
| Ca | Calcium | 20 | 40.08 | Yb | Ytterbium | 70 | 173.04 |
| Sc | Scandium | 21 | 45.10 | Lu | Lutecium | 71 | 175.0 |
| Ti | Titanium | 22 | 47.90 | Hf | Hafnium | 72 | 178.6 |
| V | Vanadium | 23 | 50.95 | Ta | Tantalum | 73 | 180.88 |
| Cr | Chromium | 24 | 52.01 | W | Tungsten | 74 | 183.92 |
| Mn | Manganese | 25 | 54.93 | Re | Rhenium | 75 | 186.31 |
| Fe | Iron | 26 | 55.85 | Os | Osmium | 76 | 190.2 |
| Co | Cobalt | 27 | 58.94 | Ir | Iridium | 77 | 193.1 |
| Ni | Nickel | 28 | 58.69 | Pt | Platinum | 78 | 195.23 |
| Cu | Copper | 29 | 63.542 | Au | Gold | 79 | 197.2 |
| Zn | Zinc | 30 | 65.377 | Hg | Mercury | 80 | 200.61 |
| Ga | Gallium | 31 | 69.72 | Tl | Thallium | 81 | 204.39 |
| Ge | Germanium | 32 | 72.60 | Pb | Lead | 82 | 207.21 |
| As | Arsenic | 33 | 74.91 | Bi | Bismuth | 83 | 209.00 |
| Se | Selenium | 34 | 78.96 | Po | Polonium | 84 | 210 |
| Br | Bromine | 35 | 79.916 | At | Astatum | 85 | 210 |
| Kr | Krypton | 36 | 83.7 | Rn | Radon | 86 | 222 |
| Rb | Rubidium | 37 | 85.48 | Fr | Francium | 87 | 221 |
| Sr | Strontium | 38 | 87.63 | Ra | Radium | 88 | 226.05 |
| Y | Yttrium | 39 | 88.92 | Ac | Actinium | 89 | 227 |
| Zr | Zirconium | 40 | 91.22 | Th | Thorium | 90 | 232.12 |
| Nb | Niobium | 41 | 92.91 | Pa | Protactinium | 91 | 231 |
| Mo | Molybdenum | 42 | 95.95 | U | Uranium | 92 | 238.07 |
| Tc | Technetium | 43 | 98.91 | Np | Neptunium | 93 | 237.07 |
| Ru | Ruthenium | 44 | 101.7 | Pu | Plutonium | 94 | 239.08 |
| Rh | Rhodium | 45 | 102.91 | Am | Americium | 95 | 243 |
| Pd | Palladium | 46 | 106.7 | Cm | Curium | 96 | 244 |
| Ag | Silver | 47 | 107.880 | Bk | Berkelium | 97 | 245 |
| Cd | Cadmium | 48 | 112.41 | Cf | Californium | 98 | (246) |
| In | Indium | 49 | 114.76 | | | 99 | |
| | | | | Ct | Centurium | 100 | (248) |

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[1] We are indebted to Mr. Grégoire of the *Institut du Radium* (Paris) who kindly gave us the latest data concerning atomic masses.

## APPENDIX III

## SHORT LIST OF SUPPLIERS OF SCIENTIFIC INSTRUMENTS

AUSTRALIA

Abacus Instrument Co.
122 King St.
Melbourne

Dobbie Bros. (Thermometers)
80 Little Lonsdale St.
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BELGIUM

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17, Rue des Drapiers
Brussels

Société Belge d'Optique et d'Instruments de Précision
110, Rue de la Prairie
Ghent

DENMARK

Association of Scientific Instrument Manufacturers Industriraadet
18 Vestre Boulevard
Copenhagen 5

H. Struers Chemiske Laboratorium
38 Skindergade
Copenhagen

FRANCE

Association Interprofessionnelle des Constructeurs de Matériel d'Equipement Scientifique (AICMES)
(12 member federations comprising 165 firms)
61, Rue de Malte
Paris, 11e

F.O.P.E.X (group of 32 industrials)
61, Rue de Malte
Paris, 11e

GREAT BRITAIN

Scientific Exports (Great Britain) Ltd. (SCIEX) (comprising 7 firms)
Buckingham House, Buckingham St.
Adelphi, London, W. C. 2

Scientific Instrument Manufacturers' Association of Great Britain Ltd. (SIMA) (comprising 84 firms)
17 Princes Gate
London, S. W. 7

ITALY

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2 Via Regina Elena
Rome

Associazione Nazionale Industria Meccanica e Metallurgica
3 Piazza Mignanelli
Rome

NETHERLANDS

Vereeniging van Nederlandsche Instrumentfabrikanten
73 Voorstraat
Delft

SWEDEN

Rudolph Grave Aktiebolaget
48 C Malmskillnadsgatan
Stockholm

Norstedt & Soner
17 Bryggaregatan
Stockholm

Axel Kistner
20-22 Wallingatan
Stockholm

SWITZERLAND

Association Suisse des Constructeurs de Machines (V. S. M.)
4, General Wille Strasse
Zürich 2

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